CHAPTER 500 INSTALLATION OF STORMWATER FACILITIES

SECTION 501 STORM SEWER PIPE AND OPEN CULVERT INSTALLATION

501.01
Introduction

Storm sewer pipes and open culverts shall be laid to the lines and grade shown on the approved construction drawings, unless otherwise approved by the Department.

The design plans and specifications submitted to the department for issuance of a stormwater permit shall include a detailed trench drawing showing placement of the storm sewer pipe or open culvert within the trench, trench walls, type and depth of bedding and backfill materials, and compaction levels in conformance with those guidelines set forth herein.

The standard proctor density referenced herein is intended to mean the maximum dry density of a backfill material as determined by those methods set forth within ASTM D 698. The percent standard proctor density refers to a ratio of the in-place dry density of a backfill material, determined by those methods set forth within ASTM D 1556, to the maximum dry density (determined by Test Method 698). The resulting quotient must be multiplied by 100, and the value obtained must meet or exceed those minimum values specified herein.

501.02
Point of Commencement and Direction of Laying

The point of commencement for laying of storm sewer pipe, open culverts, and subsurface drainage tiles should be the lowest point in the proposed line. Provisions for beginning construction at other than the lowest point in the proposed line shall be approved by the design consultant. All bell and spigot pipe shall be laid with the bell end, or with the receiving groove end of tongue and groove pipe pointing upgrade.

Each pipe shall be laid on an even firm bed throughout its length, so that no uneven strain will come to any single portion of the conduit. Particular care shall be taken to prevent the total load from bearing on the pipe sockets. To accomplish this, all bells of bell and spigot pipes shall be carefully placed into a receiving hole excavated into the pipe bedding material.

All pipes shall be properly joined, utilizing the manufacturer's assembly marks, if provided. Adequate pressure shall be applied to the center of each tongue and groove pipe to ensure the proper joint seal is achieved.

501.03
Establishment of Line and Grade

A professional engineer or land surveyor registered in the state of Indiana will be required to set, or oversee the setting of, all bench mark stakes necessary for storm sewer pipe, open culvert, manhole, and subsurface drainage tile installation. Bench marks shall be set in strategic locations within the project in order to facilitate the installation of grade stakes. Horizontal and vertical control of storm sewer pipe structures, open culverts, manholes, and precast box inlets will be required to be provided

with record drawings to be submitted to the Department upon completion of the project.

The accepted method of establishing and following line and grade in conformance with the approved construction plans may be determined by the Contractor.

501.04
Jetting or Flooding of Backfill

Jetting or flooding of the backfill shall not be used without the approval of the Indianapolis Department of Transportation (IDOT), or the Indiana Department of Transportation (INDOT), as jurisdiction allows, and this Department.

501.05
Multiple Pipe Installations and Skewed Culverts

When two or more conduits are to be installed in parallel lines, the following minimum spacings for pipe, pipe-arch, and arches must be provided between the outer most portion of the pipe walls:

PIPE		PIPE-ARCHES		ARCHES
Diameter	Spacing	Span	Spacing	Spacing
Up to 24"	12"	Up to 36"	12"	2'
24" to 72"	½ Pipe O.D.	36" to 108"	1/3 Span	
Over 72"	36"	108" to 189"	36"	

Open culverts of 72" diameter and larger placed at a skew of greater than 15-degrees must have the surrounding embankment contoured to provide side support along the total length of the pipe structure.

501.06
Steep Slope Applications

Use of flange bolted ductile iron pipe, reinforced concrete pipe with poured-in-place concrete anchors (1 per pipe section), or banded corrugated metal pipe with poured-in-place concrete anchors (1 per pipe section) shall be required on those slopes greater than 15-percent (15%) to prevent joint separations and consequent system failures. Due to the potential abrasive forces of flow within systems possessing fifteen (15) percent or greater slopes, corrugated metal pipes and pipe-arches used in these applications shall possess a minimum metal thickness of 0.109 inches (12 gage), in addition to the required bituminous coating and invert paving specified within Chapter 400 of this Manual.

501.07
Material Handling

Suitable tools and equipment shall be used for the safe and convenient handling and installation of all stormwater facilities. All pipe shall be unloaded with care. Corrugated metal pipe shall not be rolled or dragged over gravel or rock, and shall be prevented from striking or resting upon

rock or other hard objects during installation. Great care must be taken to prevent pipe coatings or wrappings from being damaged. Each section of pipe shall be carefully examined for cracks and other defects prior to installation. Pipe or fittings found to be cracked, broken, or otherwise defective either before, during, or after installation, shall be removed and replaced with sound material.

All pipes, gaskets, and other fittings shall be thoroughly cleaned prior to installation. Failure to properly clean construction materials and appurtenances during all phases of installation and acceptance may result in a faulty completed system which will require replacement.

No portion of a storm sewer pipe, open culvert, manhole, inlet, or subsurface tile system may be installed indirectly onto frozen ground or with frozen backfill material.

501.08 Minimum Construction Cover

Until such time as a minimum of four (4) feet of compacted fill material has been placed over installed storm sewer pipe or open culvert sections, the contractor shall not use heavy equipment in such a way as to cause damage to these structures.

501.09 Trench Box Pulling and Sheeting

When required by the Occupational Safety and Health Act (OSHA) to protect life, property, or the work, sufficient protective measures shall be utilized in accordance with CFR 1926. Upon completion of the work, all temporary forms, shores, and bracing, other than as specified herein, shall be removed. The minimum required density of structural backfill shall not be reduced during trench box pulling. All voids left by the removal of sheeting shall be carefully filled with properly compacted bedding material.

Any damage to pavement or other structures due to sheeting, shoring, or bracing shall be repaired by the Contractor at his own expense. The City of Indianapolis, Department of Capital Asset Management, will not assume any liability for the actions of the developer, or his agent(s), in the performance of the required sheeting, shoring and bracing operations.

Sheeting and bracing which is to remain in place shall be cut off at the elevation of 1.5 feet above the top of the storm sewer pipe or open culvert.

501.10 Trench Dewatering

Where groundwater is encountered, the Contractor shall make every effort necessary to secure a dry trench bottom prior to installation of the stormwater facility in conformance with Section 715 of the Indiana Department of Transportation Standard Specifications. The Contractor shall provide, install, and operate sufficient trenches, sumps, pumps, hoses, piping, wellpoints or other means necessary to depress and maintain the groundwater level below the base of the excavation.

The Contractor shall be responsible for diverting or removing surface runoff and other accumulations of surface water from excavations. The City will not assume any liability for the actions of the developer, or his agent(s), in the performance of the required dewatering operations. If pipe structures cannot be installed under trench conditions as outlined herein, all installation activities shall be terminated until acceptable conditions can be achieved. The Department shall reserve the right to terminate installation activities under those trench conditions which are not in conformance with this Manual.

Under no circumstances shall surface water and/or groundwater be discharged to, disposed of, or allowed to flow into the City of Indianapolis sanitary sewer system without approval from the Department.

501.11 Abandoned Sewers

Sanitary sewers, combination sewers, and stormwater conduits which are to be abandoned shall be bulkheaded with mortar and an eight (8) inch thick solid concrete brick wall. Sanitary sewers, combination sewers, stormwater conduits, and appurtenant structures which are to be abandoned in place shall be filled with sand or Cellular Concrete and plugged, unless otherwise indicated on the approved construction plans.

Service shall be maintained within sanitary and combination sewers until the Department shall order bulkheads placed. Bulkheads shall be placed within stormwater conduits at the discretion of the design consultant.

No timber bulkheads shall be allowed. Unless otherwise specified, all abandoned manholes, catch basins and inlets shall be removed to a depth of three (3) feet below the proposed or established ground elevation, or existing street grade, whichever is lower.

501.12 Trench Installations

For trench installations, the supporting soil beneath the pipe structure shall be defined as the foundation material. The pipe bedding is that portion of the backfill material which is shaped to contact the sides and bottom of the conduit, to prevent lateral displacement, and for establishment of design grades. Initial backfill shall be defined as that material placed from the pipe springline (½ the outside vertical pipe height) to twelve (12) inches over the crown of the pipe. Regular backfill shall be that material placed from the initial backfill to the ground or road surface.

Bedding and backfill material classes referenced within this chapter shall be defined as follows:

Class I Angular, six (6) to forty (40) millimeters (1/4 to 1 ½ inch) graded stone such as crushed stone. Indiana Department of Transportation (INDOT) Classification No. 5, No. 8, and No. 9, and No. 53. A No. 8 gravel possessing a minimum 50% mechanical crush count, and meeting the following nominal sizes and percents passing will be considered an equivalent

Class I material: 100% passing 1" sieve; 75-95% passing 3/4" sieve; 40-70% passing ½" sieve; and 0-15% passing No. 4 sieve.

Class II Coarse sands and gravel-sand mixtures with a maximum particle size of forty (40) millimeters (1-1/2 inches), including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil types GW, GP, SW and SP are included in this class. Indiana Department of Transportation (INDOT) Classification for "B" borrow material.

Class III Fine sand and clay gravels, including fine sands, sand-clay mixtures and gravel-clay mixtures. Soil types GM, GC, SM and SC (ASTM D 2487) are included in this class. These materials will not be accepted as pipe bedding.

Class IV Silt, silty clays and clays, including organic- clays and silts of medium to high plasticity and liquid limits. Soil types MH, ML, CH and CL (ASTM D 2487) are included in this class. These materials will not be accepted as pipe bedding.

These materials shall be utilized for installation of stormwater facilities in accordance with and in the manner specified by this chapter.

Whenever pipe trenches are inadvertently excavated below the designed bedding bottom, the Contractor shall fill the over-excavated area with Class I or Class II granular bedding material, compacted and shaped to form a firm, uniform trench base.

In those cases where a firm foundation is not encountered at the required grade, the unstable material shall be removed to such depth that when replaced with suitable Class I or Class II material, compacted, and properly shaped, to produce a uniform and stable foundation along the entire length of the pipe.

Bell holes shall be properly excavated for bell and spigot pipe, so that the entire barrel of the pipe rests directly upon the bedding material.

All rocks, boulders and stones 6-inches in diameter and larger encountered in trenches shall be removed. Boulders or rocks are not to be used for any portion of the trench backfill.

501.13
Minimum
Trench Width

Except as provided herein, the minimum trench width for storm sewers of 42-inch or equivalent diameter and smaller shall be 1.25 times the outside diameter (Bc) of the pipe plus 12-inches, and in no case shall provide less than nine (9) inches between the edge of the pipes and the trench wall.

The minimum trench width for storm sewers larger than 42-inch or equivalent diameter shall be 1.25Bc + 24 inches, and in no case shall provide less than twelve (12) inches between the edge of the pipe and trench wall.

For flexible conduits, the lateral resistance of in-situ soils shall be of sufficient stiffness to provide the required pipe support. Where unstable trench sidewall conditions exist, or where trench depth dictates the use of a moveable trench box, the design consultant must determine the width of compacted bedding and backfill material necessary to provide adequate pipe or culvert side support.

The trench widths derived by these equations provide a minimum only. Exceptions to these minimums apply only to concrete pipes located at least 5' outside of the edge of pavement. Under these conditions, the design consultant must assume responsibility for determining the appropriate minimum trench width based upon a structural evaluation of the pipe material.

501.14 Bedding and Backfill Materials

Figures 501-03 through 501-12 should be referenced for an illustration of storm sewer pipe and open culvert bedding and backfill materials required by the Department for each pipe material class. For the purpose of these specifications, the DOT pavement zone shall be defined as that area within five (5) feet of any edge of pavement, curb, gutter, sidewalk, or similar structure in the public right-of-way. Bedding and backfill requirements for each type of pipe material are summarized as follows:

1. Corrugated Metal Pipe (CMP) (Figure 501-03, 501-04)

Bedding

Corrugated Metal Pipe (CMP) conduits shall be provided with Class I or Class II granular bedding material from three (3) to six (6) inches (based upon pipe diameter) below the pipe barrel, to twelve (12) inches above the crown of the pipe.

Class I material shall be shovel sliced or otherwise carefully placed and "walked" or hand tamped into place to ensure proper compaction and complete filling of all voids. Class II material shall be compacted to 40-percent Standard Proctor Density as a minimum, except where the edge of the pipe trench is located within the DOT pavement zone as specified herein, where Class II material shall be compacted to 95-percent Standard Proctor Density.

Bedding shall be placed in 6" to 12" balanced lifts.

Initial Backfill

From the pipe springline, corrugated metal pipe conduits shall be backfilled with Class I or Class II material as shown in the Standard Details.

Initial backfill shall be placed in 6" to 12" balanced lifts.

Regular Backfill

Corrugated metal pipes located outside the applicable DOT pavement zone may be backfilled from twelve (12) inches above the crown with clean material, as shown in the Standard Details.

2. Reinforced Concrete Pipe (RCP) (Figure 501-07, 501-08, 501-11 and 501-12)

Bedding

Reinforced Concrete Pipe (RCP) conduits shall be provided with Class I or granular bedding material. Class II material shall be shovel sliced or otherwise carefully placed and "walked" or hand tamped into place from three (3) to six (6) inches (based upon pipe diameter) below the pipe barrel, to 1/6th the outside pipe diameter (Bc). Class II material shall be compacted to 90-percent Standard Proctor Density, as a minimum, except where the edge of the pipe trench is located within the DOT pavement zone as specified herein, where Class II material shall be compacted to 95-percent Standard Proctor Density.

Initial and Regular Backfill

Reinforced concrete pipe conduits located within the applicable DOT pavement zone shall be backfilled from the haunch area with "B" Borrow backfill compacted to 95-percent Standard Proctor Density.

Reinforced concrete pipes located outside of the DOT pavement zone shall be backfilled from the haunch area with clean material as shown on the approved construction drawings.

3. Plastic (PVC, HDPE) Pipe (Figure 501-05 and 501-06).

Bedding and Initial Backfill

Plastic Pipe conduits (PVC and HDPE) shall be provided with No. 8 crushed stone or approved Class I granular bedding material shovel sliced or otherwise carefully placed and "walked" or hand tamped into place from four (4) to six (6) inches (based upon pipe diameter) below the pipe barrel, to a minimum of twelve (12) inches above the crown of the pipe.

Bedding and initial backfill material shall be hand placed around the haunch and sides of the plastic pipe, to ensure proper compaction and complete filling of all voids.

All bedding and initial backfill shall be placed in 6" to 12" balanced lifts.

Regular Backfill

Plastic pipe conduits located within the DOT pavement zone shall be backfilled from twelve (12) inches above the crown of the pipe with "B" Barron backfill compacted to 95-percent

Standard Proctor Density.

Plastic pipes located outside of the applicable Department of Transportation pavement zone shall be backfilled from twelve

(12) inches above the crown of the pipe with clean material as shown on the approved construction drawings.

4. Reinforced Concrete Box Sections (Figure 501-09)

Reinforced concrete box sections shall be placed on a minimum of six (6) inches of No. 8 crushed stone, or other approved equivalent Class I granular bedding material, "walked" or hand tamped into place.

The regular backfill of reinforced concrete box sections located within the applicable DOT pavement zone shall be with "B" Barron backfill compacted to 95-percent Standard Proctor Density.

Reinforced concrete box sections located outside of the DOT pavement zone shall be backfilled with clean material as shown on the approved construction drawings.

The trench width for box sections shall be only as wide as is necessary to facilitate proper compaction of backfill material, provided the adjacent embankment material is structurally adequate to provide the necessary side support.

Verification of sufficient bearing strength of underlying soil foundation material, based upon manufacturer's recommendations, shall be required by the Department for all reinforced concrete box sections possessing a span greater than 12'. Soil boring report and bearing strength analysis shall be submitted with the drainage permit application.

5. Structural Plates (Figure 501-10)

The installation of structural plate pipe, pipe-arches and arches shall be in full conformance with ASTM A 807.

Structural plates located within the applicable DOT pavement zone shall be backfilled with "B" Barron backfill compacted to 95-percent Standard Proctor Density.

Structural plates located outside of the DOT pavement zone shall be backfilled with clean material as shown on the Standard Details.

A concrete footing that is either slotted to receive the corrugated shell, or mounted with aluminum receiving angles will be the only accepted method for placement of aluminum arches and box culverts. The size of footing pads and steel reinforcement shall be established by a professional engineer registered in the state of Indiana, based upon anticipated

loading and soil-bearing capacity. The depth of the bottom of the footing shall be established a minimum of 18-inches below the anticipated scour depth. Additional requirements may be made by the Department based upon an evaluation of the individual site conditions.

Verification of sufficient bearing strength of underlying soil foundation material, based upon manufacturer's recommendations, shall be required by the Department for all multi-plate drainage structures possessing a span of greater than 15-feet. Soil boring report and bearing strength analysis shall be submitted with the drainage permit application.

501.15
Height of Cover Tables

Minimum and maximum height of cover tables for flexible pipe conduits (CMP, HDPE, PVC) are provided within Tables 501-1 through 501-9, which have been developed from the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges. The structural design of rigid pipe materials shall also be in accordance with the most restrictive of either manufacturers recommendations, or AASHTO structural design methods.

Structural design computations used to determine cover depths other than those specified herein shall be submitted to the Department for review and approval and shall be certified by professional engineer registered in the State of Indiana prior to submittal.

501.16
Embankment Installations

Enclosed storm sewer piping systems are typically installed in a trench condition where the pipe is installed in a relatively narrow trench excavated in undisturbed soil, and then covered with backfill extending to the ground surface. Storm sewers and open culverts may also be installed in an embankment fill situation, where the conduit is overlaid by a constructed embankment. For embankment installations, a minimum width of properly compacted bedding and backfill material is required to ensure that adequate stiffness of the pipe envelope is developed.

The design consultant will be responsible for establishing the minimum embedment width for embankment installations, utilizing those bedding and backfill materials specified herein, in full conformance with those minimum standards set forth by the American Association for State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges, latest revision. Such factors as pipe stiffness, embedment stiffness, nature of in-situ soil, and anticipated construction and service loading shall be evaluated.

SECTION 502 INSTALLATION OF PRECAST MANHOLES AND BOX INLETS

502.01
Introduction

The following information provides a summary of construction and installation procedures required by the Department for installation of storm sewer manholes and concrete box inlets.

502.02
Preparation of Base and Backfilling

The bottom of the excavation/trench for the manhole or box inlet shall be filled with a minimum of six (6) inches stone bedding to form a stable base. Where poor or unstable soil conditions exist, or over excavation has occurred, additional No. 2 stone or Class B concrete shall be used to form a stable base.

Manhole and box inlet backfilling and compaction levels shall comply with the minimum requirements and specifications as outlined herein for the adjacent storm sewer pipe structure.

502.03
Placement of Manhole Sections

Precast manhole sections shall be placed and aligned to provide vertical sides. The completed manhole shall be rigid, true to dimensions and soiltight.

The joints between manhole sections shall be properly sealed utilizing an approved rubber gasket in accordance with ASTM C 443, non-asphaltic mastic, or butyl rubber plaster material as specified within Chapter 400 of this Manual.

502.04
Placement of Adjusting Rings and Spacers

Precast concrete manhole and box inlet adjusting rings and spacers shall be installed as specified within Chapter 400 of this Manual. All adjusting ring and spacer joints shall be sealed utilizing one-half (½) inch diameter cords of extrudable preformed gasket material, non-asphaltic mastic, or butyl rubber plaster. This material shall be placed in joints and keyways and be of sufficient quantity to completely fill the joint cavity.

502.05
Connections To Manholes

All storm sewer pipe connections to new or existing manholes and precast concrete box inlets shall be as outlined within Chapter 400 of this Manual. Connections of subsurface drainage tiles, or other subsurface drainage lines, to manholes and box inlets shall be accomplished using either precast, or drilled holes, properly sealed with non-shrink cement grout or trowelable grade butyl rubber plaster.

Where connections are made to existing manholes or box inlets, that structure shall be rehabilitated or replaced to those minimum standards outlined herein. This rehabilitation shall include the installation of bench walls, as well as prescribed measures to eliminate the potential for migration of backfill materials into the stormwater system.

Where connections of subsurface tiles to the storm sewer system cannot be made at a manhole or box inlet structure, blind "T" connections to storm sewer pipe structures will be allowed on a case basis by the Department, provided the connection holes are properly cut or core-drilled, and a minimum 6-inch inside diameter cleanout connection is also provided.

SECTION 503 INSTALLATION OF SUBSURFACE TILES

503.01 Introduction

The information outlined below is intended to summarize backfill materials and construction procedures accepted by the Department for the installation of subsurface drainage tiles. All subsurface tiles must be laid to the lines and grade shown on the approved construction drawings, unless otherwise approved by the Department.

503.02 Trench Construction

The following trench construction requirements shall be adhered to as a part of the installation of all subsurface drainage tiles.

1. Trench Bottom

   The trench bottom shall be smooth and free of large (greater than three (3) inches in diameter) exposed rock. Where an unstable trench bottom is encountered, such as with silty or fine sandy soils, a firm trench bottom must be provided. Care must be taken to prevent silt or fine sand material from entering the tile system. This may be accomplished through the use of a envelope of No. 8 gravel or comparable sized washed stone. Filter cloth barriers may also be required. Unstable soil material shall be removed and replaced with a foundation and bedding of processed stone or gravel.

2. Trench Width

   The trench width below the top of the tile must be sufficient to provide adequate clearance for joining of tile ends with standard fittings, and for placement of required bedding materials. For placement of a gravel or washed stone envelope or filter as required, a minimum trench width of four (4) inches on both sides of the tile will be required.

Subsurface drainage tiles shall be designed and installed at a minimum grade of 0.1 percent, unless otherwise approved by the department.

503.03 Gravel Envelopes and Backfilling

In order to improve the flow of ground water into the subsurface drainage tile, washed stone or gravel envelopes will be required for all subsurface drainage tile installations.

Subsurface tile gravel envelopes shall be of #8 gravel (INDOT Standard Specifications), or an approved washed stone equivalent. Gravel envelope material shall be clean, hard, and durable, with less than 5-percent passing the No. 200 sieve, not more than 30-percent passing the No. 60 sieve, and having a maximum size of 1 ½ inches. Figures 503-1 and 503-2 should be referenced for the required methods of installation and backfilling of subsurface drainage tile.

503.04
Minimum Cover Requirements

A minimum cover depth of eighteen (18) inches of earth or equivalent cover over the top of the tile will be required, except as allowed by Chapter 400 of this Manual. A temporary earth fill may be required over the subsurface drainage tile in order to provide adequate protection of this system during construction.

503.05
Minimum Levels of Workmanship

The following minimum levels of workmanship shall be adhered to as a part of the installation of all subsurface drainage tiles.

1. Handling of Subsurface Tiles

Suitable tools and equipment must be used for the safe and convenient handling and placement of subsurface drainage tiles. Plastic tile and fittings must be protected from deformation or structural deterioration due to extreme temperatures or Ultraviolet radiation. Each section of tile must be carefully examined for cracks or other defects prior to installation. Tile or fittings known to be defective must not be installed.

Each section of subsurface drainage tile must be laid on an even firm bed throughout its length, as specified herein, so that no uneven strain will come to any single portion of the tile. Suitable bedding material must be provided so that side walls are continuously and uniformly supported, and sufficient lateral restraint is provided to protect the tile against deflection and collapse during backfilling.

2. Effect of Low Temperatures

Extreme care must be taken during cold weather installations to prevent cracking of the tubing during placement in the trench, and backfilling.

3. Joints and Fittings

All drainage tile fittings shall be installed in accordance with those instructions furnished by the manufacturer. Coupling bands shall be used at all joints and fittings, at all changes in direction, changes in diameter, junctions with other tile lines, and at the ends of tile lines. Hand-cutting of holes for tile connections shall be considered permissible, provided are is taken when making the connection not to create a means of obstructing flow, catching debris, or allowing soil to enter the tile line.

503.06
Outlet Protection

A minimum length of twenty (20) feet of polyvinyl chloride (PVC) or double walled high density polyethylene (HDPE) pipe meeting the material specifications of this Manual shall be used at the surface outlet end of all

subsurface drainage tiles, with at least two-thirds of the pipe length

embedded in the bank to provide adequate support. Animal guards shall also be provided.

503.07 Rodent Protection

The outlet end of the subsurface drain tile must be equipped with an animal guard to protect the system from entry and damage by rodents or other animals. Where tiles are connected to old existing tile lines that may serve as animal runs, an animal guard must be installed within the newly constructed line to restrict animal travel.

503.08 Location of Existing Tiles

All plans and specifications submitted to the Department for review and approval shall delineate, when possible, the approximate location of existing agricultural or other subsurface drainage tiles. All existing subsurface drainage tiles shall be perpetuated across the construction site. Extreme care must be taken to prevent damage to these existing lines. Any existing tile lines which are inadvertently damaged or cut during construction shall be repaired or replaced.

SECTION 504 OPEN CHANNEL CONSTRUCTION

504.01 Introduction

The cross-sectional configuration of stormwater conveyance channels may be vee-shaped, parabolic or trapezoidal. Typical open channel cross-sections and linings are illustrated within Figure 504-1.

Open channels shall be constructed to the line, grade, and cross-section shown on the approved construction plans. Earthen fills beneath concrete or rock rip-rap lined channels shall be compacted to 95-percent Standard Proctor Density.

504.02 Open Channel Stabilization

The types of treatments used to stabilize open channels may vary with flow velocities and individual site conditions within the following guidelines:

1. Grass-lined Channels

The grass mixture chosen for stabilization of open conveyance channels shall be based upon specific site conditions; i.e., drainage tolerance, shade tolerance, and maintenance requirements. Grass-lined stormwater conveyance channels shall be permanent seeded within seven (7) days after finish grading.

To facilitate vegetative establishment, the flowline of

grass lined stormwater conveyance channels shall be protected utilizing an approved erosion control blanket designed and installed according to the applicable manufacturer's specifications.

The maximum allowable side-slope of grass lined channels shall be 3 (horizontal) to 1 (vertical). The bottom width of trapezoidal grass-lined channels shall not exceed fifteen (15) feet, unless rock rip-rap or paved low flow channels are provided to prevent meandering. For grass-lined channels, intended to convey continuous trickle flows such as for retention pond outlets, an enclosed storm sewer, subsurface tile with gravel envelope, rock rip-rap, or paved low flow channel will be required.

2. Rock Riprap-lined Channels

The maximum allowable side-slope of rock riprap lined open conveyance channels shall be 1 ½ (horizontal) to 1 (vertical), unless otherwise approved.

3. Concrete-lined Channels

Concrete-lined open channels shall be constructed to the dimensions and reinforcement guidelines detailed within Figure 504-2, unless alternative construction methods have been approved. Figures 504-3 and 504-4 provide construction details for lug and cut-off-wall construction for each type of paved channel. Cut-off-walls shall be monolithically poured with the paved channel at its beginning and end. Lugs shall be used for all types of paved channels as a monolithic pour at the following maximum spacing:

Up to 3% grade	300 foot spacing
3% to 5% grade	200 foot spacing
5% to 8% grade	150 foot spacing
8% to 10% grade	100 foot spacing
10% and over grade	50 foot spacing

Concrete-lined channels shall be required by the Department as deemed necessary to either control erosion and/or eliminate wetness within open stormwater conveyance channels.

504.03 Controlling Surface and Subsurface Wetness in Open Channels

To prevent chronic wetness in the invert of open channels, subsurface tiles shall be installed a minimum of 1 ½ feet in depth (from the tile invert), with a #8 gravel or equivalent size washed stone as a granular envelope, as follows:

1. Single and Double Family Residential Developments

Minor drainage collector swales in rear yards and between homes shall possess a maximum channel length of 400 lineal feet, unless subsurface tile or swale invert treatment in the form of concrete paving is also provided. The maximum vegetated

open channel side slope shall be 3 (horizontal) to 1 (vertical).

The required channel slope and invert treatment for minor drainage collector swales shall be as follows: grass lined swale if slope is 1% or greater and length is less than 400 feet; concrete paved channel if channel slope is between 0.3% and 0.5%, and/or length is greater than 400 feet; subsurface drainage tile if channel slope is between 0.5% and 1.0%, and or length is greater than 400 feet. The minimum channel slope shall be 0.3%.

For relatively large open channels and perennial streams, minimum channel slopes and the provision of subsurface drainage shall be approved on a case basis by the Department.

2. Commercial and Industrial Developments and Other Open Land Uses (Golf Courses, Parks, Recreation Areas)

The maximum length of minor drainage collector swales shall be 800 lineal feet, unless subsurface drainage or swale invert treatment in the form of concrete paving is also provided. The maximum vegetated open channel side slope shall be 3 (horizontal) to 1 (vertical).

The required channel slope and invert treatment for minor drainage collector swales shall be as follows: subsurface drainage tile and/or invert paving for channel slopes between 0.3% and 0.5%. The minimum channel slope shall be 0.3%.

For relatively large open channels and perennial streams, minimum channel slopes and other channel bank and invert treatments shall be approved on a case basis by the Department.

SECTION 505 DETENTION/RETENTION POND CONSTRUCTION

505.01 Introduction

Detention/retention facilities may be constructed as either a dry basin, or with a permanent water surface elevation. Dry basins may be utilized for flood control purposes only under those site conditions where stormwater quality issues are not required to be addressed. Dry detention basins may serve a variety of alternative uses, and may include grassed basins, which are also utilized for recreational purposes. Paved parking areas, roof tops, and underground storage vaults for stormwater detention may also be approved on a case basis.

505.02 Dry Detention Basins

For grassed dry detention basins, the minimum accepted bottom slope shall be 1.0 percent (1%). The maximum vegetated bank side-slope shall be 3 (horizontal) to 1 (vertical).

Grassed bottom slopes and minor surface water collector swales within dry detention basins which possess a flow gradient of less than 1.0 percent (1%) shall be provided with subsurface tile installed with gravel backfill material (reference Section 503 of this chapter). Collector swales within dry detention basins possessing a flow gradient of 0.3 to 0.5 percent shall be constructed with a concrete paved invert as detailed herein.

Dry detention basins shall be provided with a low flow paved channel, subsurface tile, or storm sewer system designed to convey continuous trickle flows through these facilities. This type of accommodation of low flows through dry detention basins is needed in order to facilitate maintenance of the basin.

505.03
Wet Detention/
Retention
Basins

Vegetated areas of wet detention/retention basins shall have earthen embankments constructed to a maximum slope of 3 (horizontal) to 1 (vertical). Earthen embankments armored with rock rip-rap shall not exceed 1 ½ (horizontal) to 1 (vertical). All earthen slopes shall be revegetated according to those guidelines set forth within Chapter 600 of this Manual, "Erosion and Sedimentation Control", Standard Practice No. 604.08. For wet retention basins, the bank cross-section shall be constructed as detailed within Figure 505-1 below, unless otherwise specified and approved by the Department. This method of construction will improve both the safety and water quality attributes of the proposed retention facility.

Rock rip-rap may be used at the permanent pool elevation of wet detention/retention basins for prevention of bank erosion due to wave action, or extended detention times.

The constructed levee elevation shall provide for a minimum of one (1) foot of freeboard above the maximum anticipated flow depth through the emergency spillway.

505.04
Minimum
Freeboard

Freeboard is a required horizontal and vertical distance between the computed 100YR water surface elevation of the D/R facility and other critical structures and/or improvements. The computed 100YR water surface elevation for all D/R facilities shall be a minimum ten (10) feet horizontally and two (2) feet vertically from the lowest ground elevation next to any permanent structure, such as a residential home or commercial building, for example. In addition, where construction of a emergency spillway is required, the constructed levee elevation shall provide for a minimum of one (1) foot of freeboard above the maximum anticipated flow depth through the emergency spillway during the design flow rate. Section 301.4.2 should be referenced for minimum emergency spillway design flow rates.

505.05
Anti-Seep
Devices

For leveed detention/retention facilities which generate 3-feet or more of head pressure, the principal spillway outlet pipe structure shall be provided with anti-seep devices. The construction material to be utilized for these devices shall be of like material as the pipe structure, i.e. poured in place concrete, bolted aluminized steel, or polyethylene sheet with sewn rubber boot. As a general guide, anti-seep collars shall possess a minimum dimension of 5'x 5', and be spaced a maximum of 25' apart. For further design and construction information, reference should be made to standard United States Department of Agriculture, Soil Conservation Service (SCS) design methodologies.

The spacing of anti-seep collars shall be determined by the design consultant and, where required, be clearly shown on the plan/profile drawing's of the construction plans. The material used for bedding and backfill of pipe structures through an earthen dam or levee shall be the same soil material used in construction of the surrounding embankment.

505.06
Emergency
Spillways

Embankments and levees which in some way create a water impoundment shall be provided with an emergency flood overflow outlet. This overflow may occur, as examples, as the overtopping of roadway culverts, or flow around the ends of pond dikes or levees. The constructed levee elevation shall provide for a minimum of one (1) foot of freeboard above the maximum anticipated flow depth through the emergency spillway.

Earthen, vegetated emergency spillways shall be excavated into original ground, and be evaluated for erodibility based upon soil characteristics, entrance and exit slopes, and the potential depth and velocity of flow. Additional erosion control measures within these spillways in the form of rock rip-rap or concrete paved channels may be required on a case basis by the Department.

505.07
Earthen
Embankment
Construction

Compaction levels of earthen levees shall reach 95-percent Standard Proctor Density, utilizing suitable soil materials, at appropriate moisture levels. Levees shall be provided with a core trench (cut-off trench) of compacted soil, to prevent the piping of water either beneath the levee, or around the levee ends.

TABLE 501-1: Height of Cover for Corrugated Polyethylene Pipe

ID (IN.)	OD (IN.)	MIN. WALL AREA (SQ.IN./FT.)	HEIGHT OF COVER	
			MIN (FT.)	MAX (FT.)
12.0	14.0	1.50	1.0	11.0
15.0	17.7	1.91	1.0	11.0
18.0	21.1	2.34	1.0	11.0
24.0	27.5	3.14	1.0	11.0
30.0	34.1	3.92	1.0	11.0
36.0	41.0	4.50	1.0	11.0
MEETS AASHTO M294, MINIMUM CELL CLASS ASTM D 3350. 324420C				

FOOTNOTE TO TABLE 501-1:

*Minimum height of cover shall be twelve (12) inches for unimproved (unpaved) areas.

*Minimum cover shall be measured from the valley of the corrugation of the pipe to either the ground surface, the bottom of flexible pavement, or to the top of rigid pavement.

TABLE 501-2: Height of Cover for Ribbed Polyethylene Pipe

			HEIGHT OF COVER	
			FU = 1125 psi	
ID (IN.)	OD (IN.)	MIN. WALL AREA (SQ. IN./FT.)	MIN (FT.)	MAX (FT.)
18.0	21.0	2.964	1.0	18.0
21.0	24.0	4.152	1.0	22.0
24.0	27.0	4.668	1.0	21.0
27.0	30.2	5.904	1.0	24.0
30.0	33.2	5.904	1.0	22.0
33.0	36.3	6.996	1.0	23.0
36.0	39.5	8.088	1.0	25.0
MEETS ASTM F 894, MINIMUM CELL CLASS ASTM D 3350. 334433C FU = MINIMUM TENSILE STRENGTH				

FOOTNOTE TO TABLE 501-2:

*Minimum height of cover shall be twelve (12) inches for unimproved (unpaved) areas.

*Minimum cover shall be measured from the valley of the corrugation of the pipe to either the ground surface, the bottom of flexible pavement, or to the top of rigid pavement.

TABLE 501-3: Height of Cover for Smooth Wall Polyethylene Pipe

DIMENSION RATIO	NOMINAL SIZES IN.)	HEIGHT OF COVER	
		MINIMUM (FT.)	MAXIMUM (FT.)
26	20 - 36	1.0	40.0
21	10 - 36	1.0	57.0
17	5 - 36	1.0	81.0
15.5	4 - 36	1.0	94.0
13.5-11	4 - 36	1.0	100.0
9.3	4 - 30	1.0	100.0
9	4 - 24	1.0	100.0
8.3	4 - 20	1.0	100.0
7.3	4 - 18	1.0	100.0
HYDROSTATIC DESIGN BASIS = 1600 psi DIMENSION RATIO = MIN. WALL THICKNESS/NOMINAL SIZE MEETS ASTM F 714, MINIMUM CELL CLASS ASTM D 3350, 335434C			

FOOTNOTE TO TABLE 501-3:

*Minimum height of cover shall be twelve (12) inches for unimproved (unpaved) areas.

*Minimum cover shall be measured from the valley of the corrugation of the pipe to either the ground surface, the bottom of flexible pavement, or to the top of rigid pavement.

TABLE 501-4: Height of Cover for Ribbed Polyvinyl Chloride Pipe

SIZE (IN.)	ID (IN.)	OD (IN.)	MIN. WALL AREA (SQ. IN./FT.)	HEIGHT OF COVER	
				MIN (FT.)	MAX (FT.)
18	17.65	18.90	2.343	1.0	34.0
21	20.75	22.15	2.635	1.0	33.0
24	23.50	25.00	2.830	1.0	31.0
27	26.50	28.15	3.084	1.0	30.0
30	29.50	31.25	3.295	1.0	29.0
36	35.50	37.50	3.719	1.0	27.0
MEETS AASHTO M304, MINIMUM CELL CLASS ASTM D 1784, 12364C OR 12364C					

TABLE 501-5: Height of Cover for Smooth Wall Polyvinyl Chloride Pipe

FU (PSI)	NOMINAL SIZE (IN.)	INSIDE DIAMETER (INCHES)	OUTSIDE DIAMETER (INCHES)	WALL AREA (IN.=/FT.)	HEIGHT OF COVER	
					MIN. (FT.)	MAX. (FT.)
*7000	12	11.784	12.500	4.296	1.0	64.0
*7000	15	14.424	15.300	5.256	1.0	64.0
#6000	18	17.703	18.701	5.988	1.0	61.0
#6000	21	20.871	22.047	7.056	1.0	61.0
#6000	24	23.481	24.803	7.932	1.0	61.0
#6000	27	26.463	27.953	8.940	1.0	61.0
#6000	30	29.816	31.496	10.08	1.0	61.0
#6000	33	33.543	35.433	11.34	1.0	61.0
#6000	36	37.270	39.370	12.60	1.0	61.0
* - MEETS AASHTO M278. MINIMUM CELL CLASS ASTM D 1784, 12454C # - MEETS ASTM F 679, MINIMUM CELL CLASS D 1784, 12364C FU = MIN. TENSILE STRENGTH						

FOOTNOTE TO TABLE 501-4 and 501-5:

*Minimum height of cover shall be twelve (12) inches for unimproved (unpaved) areas.

*Minimum cover shall be measured from the valley of the corrugation of the pipe to either the ground surface, the bottom of flexible pavement, or to the top of rigid pavement.

TABLE 501-6: Height of Cover for Corrugated Steel Pipe

DIAMETER	Corrugation Pattern					
	2 2/3" x ½"		3" X 1" and 5" x 1"		7 ½" x 3/4" x 3/4"	
	GAGE	MIN COVER	GAGE	MIN COVER	GAGE	MIN COVER
12"-36"	16	12"	--	--	16	12"
42"-48"	14	12"	--	--	14	12"
54"	14	12"	16	12"	12	12.5"
60"	12	12"	16	12"	12	15"
66"	12	12"	16	12"	12	16.5"
72"	10	12"	16	12"	12	18"
78"	8	12"	14	12"	12	19.5"
84"	8	12"	14	12"	12	21"
90"-96"	8	12"	14	12"	12	24"
102"-108"	--	--	12	18"	--	--
114"-138"	--	--	10	18"	--	--
144"	--	--	8	18"	--	--

Note:

1) Minimum cover is measured from the valley of the corrugation of the pipe to either the bottom of flexible pavement or to the top of rigid pavement.

2) Maximum height-of-cover limits shall be in accordance with AASHTO requirements and manufacturers recommendations.

TABLE 501-7: Height of Cover for Corrugated Steel Pipe Arches

Corrugation Pattern								
2 2/3" x ½"			3" X 1"			7 ½" X 3/4" X 3/4"		
SIZE	GAGE	MIN COVER	SIZE	GAGE	MIN COVER	SIZE	GAGE	MIN COVER
17"X13"	16	12"	--	--	--	--	--	--
21"X15"	16	12"	--	--	--	20"X16"	16	12"
24"X18"	16	12"	--	--	--	23"X19"	16	12"
28"X20"	16	12"	--	--	--	27"X21"	16	15"
35"X24"	16	12"	--	--	--	33"X26"	16	18"
42"X29"	14	12"	--	--	--	40"X31"	14	21"
49"X33"	14	12"	--	--	--	46"X36"	12	24"
57"X38"	12	12"	--	--	--	53"X41"	12	24"
64"X43"	12	12"	60"X46"	14	12"	60"X46"	12	24"
71"X47"	10	12"	66"X51"	14	12"	66"X51"	12	24"
77"X52"	8	12"	73"X55"	14	12"	--	--	--
--	--	--	81"X59"	14	12"	--	--	--
--	--	--	87"X63"	14	12"	--	--	--
--	--	--	95"X67"	12	12"	--	--	--
--	--	--	103"X71"	12	18"	--	--	--

Note:
1) Minimum cover is measured from the valley of the corrugation of the pipe to either the bottom of flexible pavement or to the top of rigid pavement.
2) Maximum height-of-cover limits shall be in accordance with AASHTO requirements and manufacturers recommendations.

TABLE 501-8: Height of Cover for Corrugated Aluminum Pipe

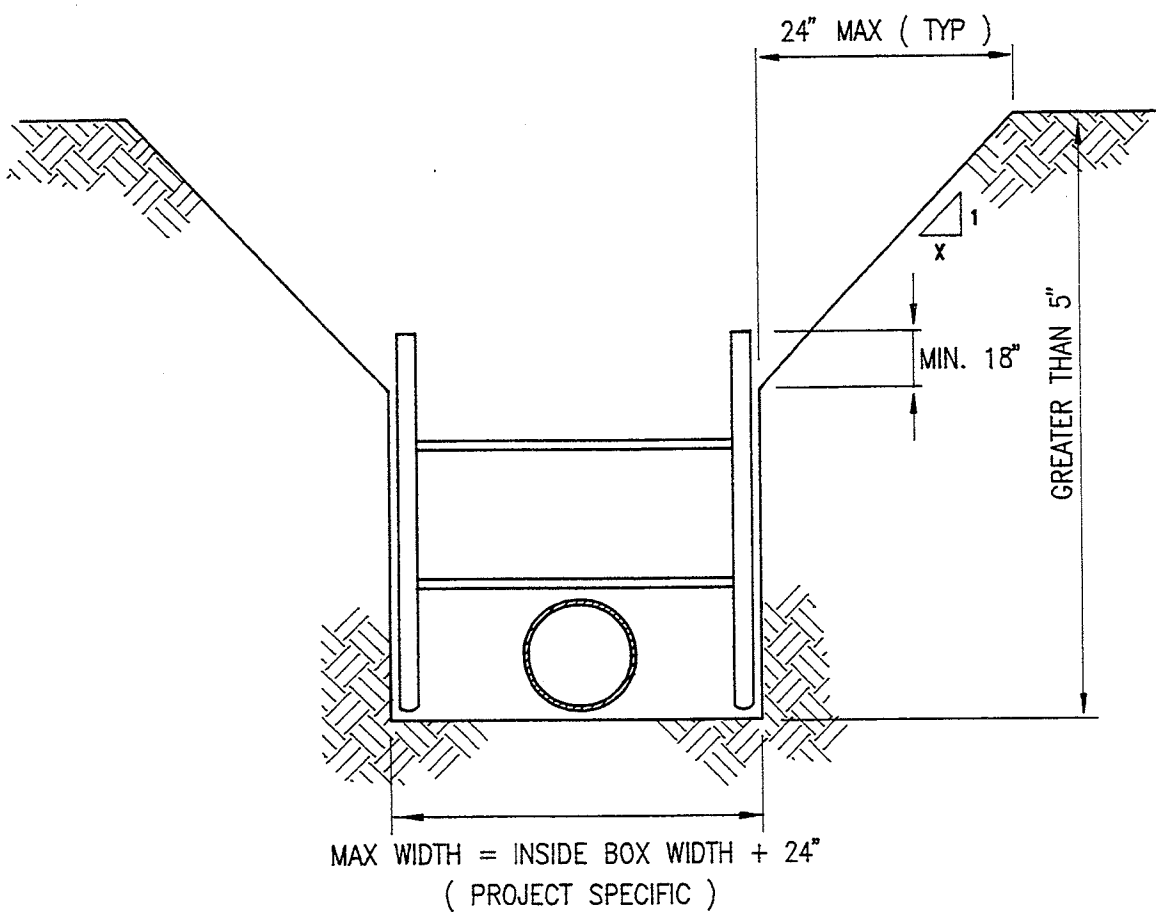
DIAMETER	Corrugation Pattern					
	2 2/3" x ½"		3" X 1" and 5" x 1"		7 ½" x 3/4" x 3/4"	
	GAGE	MIN COVER	GAGE	MIN COVER	GAGE	MIN COVER
12"-24"	16	12"	--	--	16	12"
30"	16	15"	--	--	16	15"
30"	14	12"	16	12"	14	15"
36"	16	18"	--	--	16	18"
36"	14	12"	16	12"	14	18"
42"	14	18"	--	--	14	21"
42"	12	12"	16	12"	12	21"
48"	12	12"	14	12"	12	24"
54"	--	--	--	--	12	24"
54"	12	15"	14	15"	10	24"
60"	10	15"	14	15"	10	24"
66"	8	18"	14	18"	10	24"
72"	8	18"	12	18"	10	26"
78"-84"	--	--	12	21"	--	--
90"-108"	--	--	10	24"	--	--
114"-120"	--	--	8	24"	--	--

Note:
1) Minimum cover is measured from the valley of the corrugation of the pipe to either the bottom of flexible pavement or to the top of rigid pavement.
2) Maximum height-of-cover limits shall be in accordance with AASHTO requirements and manufacturers recommendations.

TABLE 501-9: Height of Cover for Corrugated Aluminum Pipe Arches

Corrugation Pattern								
2 2/3" x ½"			3" X 1"			7 ½" X 3/4" X 3/4"		
SIZE	GAGE	MIN COVER	SIZE	GAGE	MIN COVER	SIZE	GAGE	MIN COVER
17"X13"	16	12"	--	--	--	--	--	--
21"X15"	16	12"	--	--	--	20"X16"	16	12"
24"X18"	16	12"	--	--	--	23"X19"	16	12"
28"X20"	14	12"	--	--	--	27"X21"	16	15"
35"X24"	14	12"	--	--	--	33"X26"	16	18"
42"X29"	12	12"	--	--	--	40"X31"	14	21"
49"X33"	12	15"	--	--	--	46"X36"	12	24"
57"X38"	10	15"	--	--	--	53"X41"	12	24"
64"X43"	10	18"	60"X46"	14	15"	60"X46"	12	24"
71"X47"	8	18"	66"X51"	14	18"	66"X51"	12	24"
--	--	--	73"X55"	14	21"	--	--	--
--	--	--	81"X59"	12	21"	--	--	--
--	--	--	87"X63"	12	24"	--	--	--
--	--	--	95"X67"	12	24"	--	--	--
--	--	--	103"X71"	10	24"	--	--	--

Note:
1) Minimum cover is measured from the valley of the corrugation of the pipe to either the bottom of flexible pavement or to the top of rigid pavement.
2) Maximum height-of-cover limits shall be in accordance with AASHTO requirements and manufacturers recommendations.



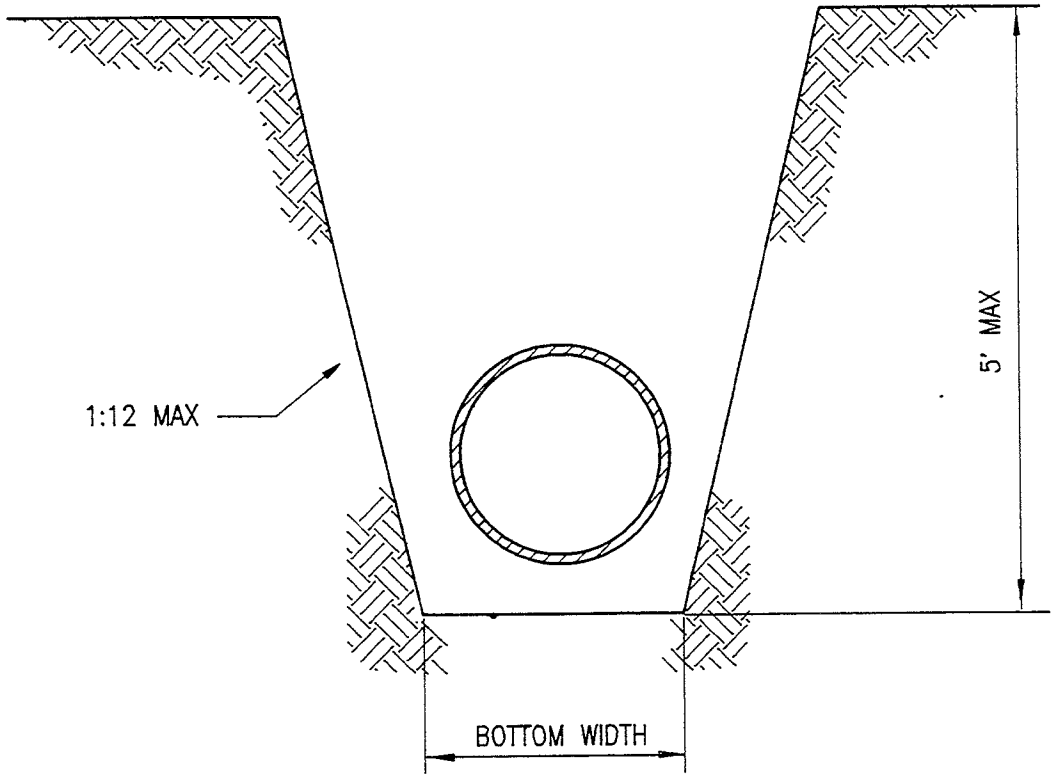
SOIL TYPE	X
A	3/4
B	1
C	1 1/2

Other means of OSHA–approved trench protection are acceptable provided the maximum trench width of this detail is adhered to.

MAXIMUM TRENCH WIDTH DETAIL FOR EXCAVATIONS

GREATER THAN 5' IN DEPTH WITHIN PUBLIC RIGHT–OF–WAY

Figure 501–01



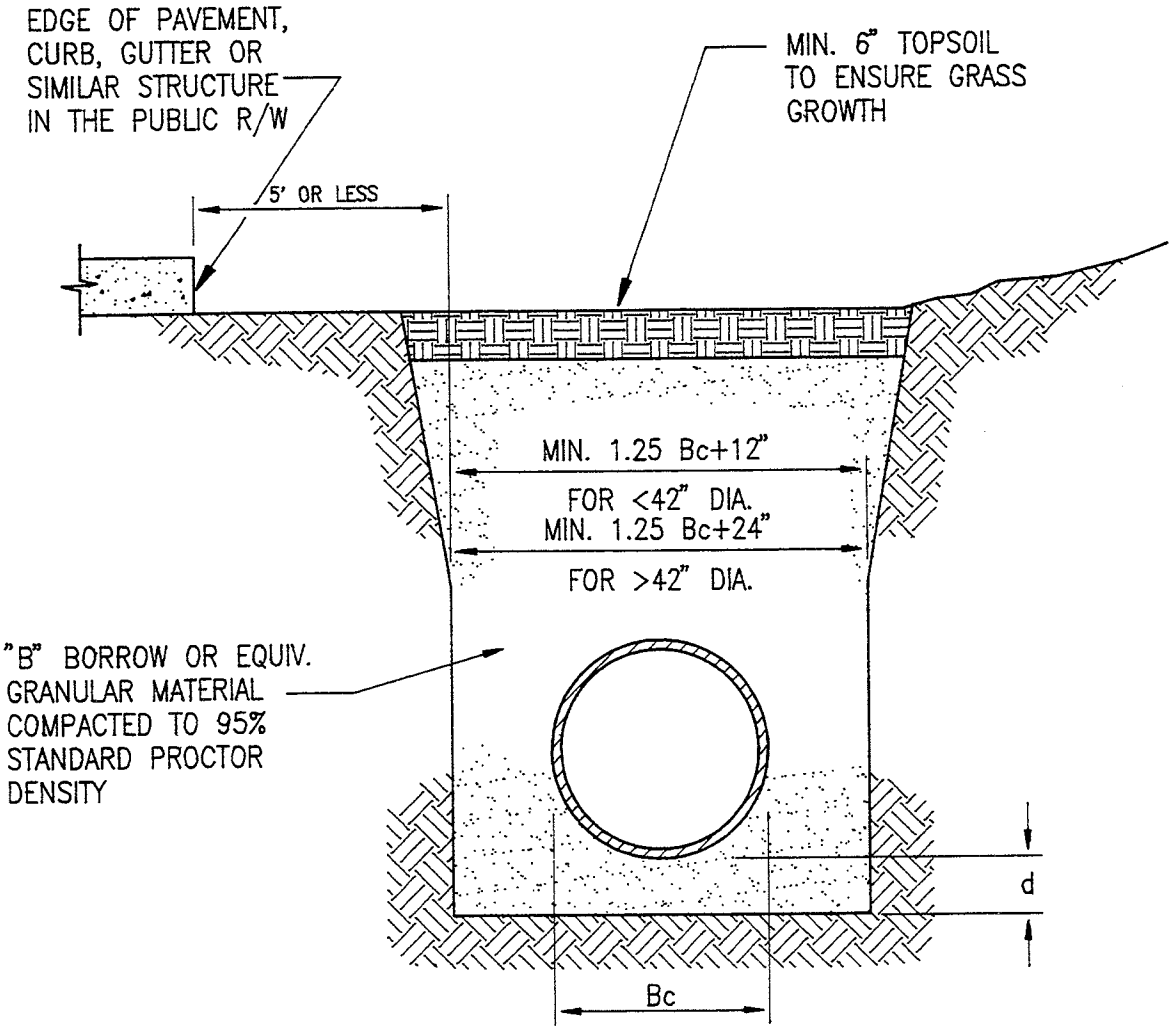
1.25 O.D. + 12" FOR < 42" DIA.
1.25 O.D. + 24" FOR > 42" DIA.

Detail shall be used if excavations are less than 5 feet in depth and examination of the ground by a competent person provides no indication of a potential cave–in. The determination of cave–in potential shall be the responsibility of the contractor. If contractor determines a potential cave–in is possible, trench protection shall be provided per OSHA standards. OSHA standards shall be used in all cases.

MAXIMUM TRENCH WIDTH DETAIL FOR EXCAVATIONS

5' OR LESS IN DEPTH WITHIN PUBLIC RIGHT–OF–WAY

Figure 501–02



WITHIN 5" OF EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

MIN. 9" CLEARANCE EACH SIDE OF PIPE FOR 42" DIA. AND LESS

MIN. 12" CLEARANCE EACH SIDE OF PIPE FOR LARGER THAN 42" DIA.

DEPTH OF BEDDING MATERIAL BELOW PIPE

D	(d) MIN.
27" & SMALLER	3"
30" TO 60"	4"
66" & LARGER	6"

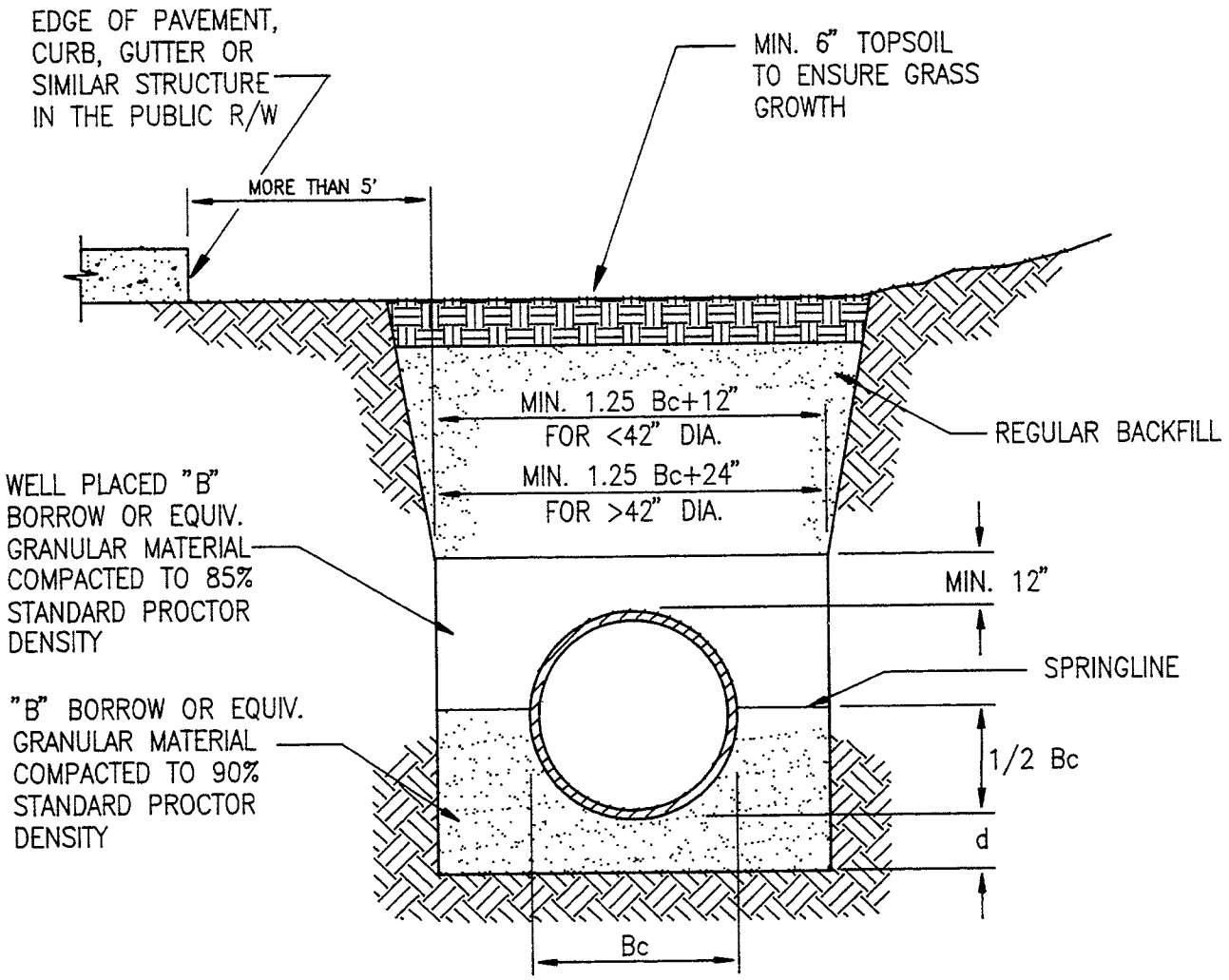
LEGEND

Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

CORRUGATED METAL PIPE (CMP) TRENCH DETAIL

WITHIN 5' OF EDGE OF PAVEMENT

Figure 501-03



GREATER THAN 5' FROM EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

MIN. 9" CLEARANCE EACH SIDE OF PIPE FOR 42" DIA. AND LESS

MIN. 12" CLEARANCE EACH SIDE OF PIPE FOR LARGER THAN 42" DIA.

DEPTH OF BEDDING MATERIAL BELOW PIPE

D	(d) MIN.
27" & SMALLER	3"
30" TO 60"	4"
66" & LARGER	6"

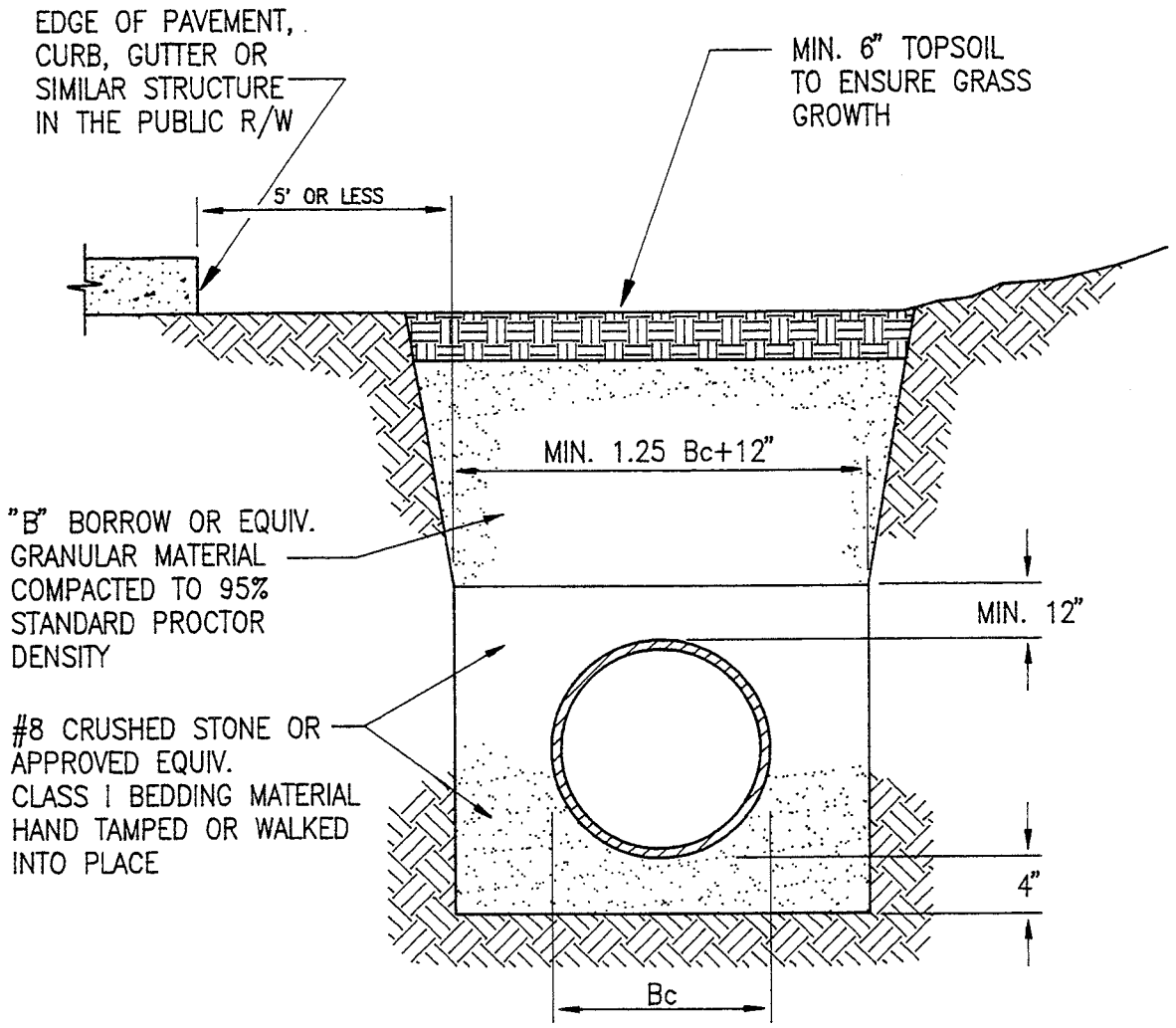
LEGEND

Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

CORRUGATED METAL PIPE (CMP) TRENCH DETAIL

GREATER THAN 5' FROM EDGE OF PAVEMENT

Figure 501-04



WITHIN 5" OF EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

A MINIMUM 9" CLEARANCE SHALL BE PROVIDED ON EACH SIDE OF THE INSTALLED PIPE

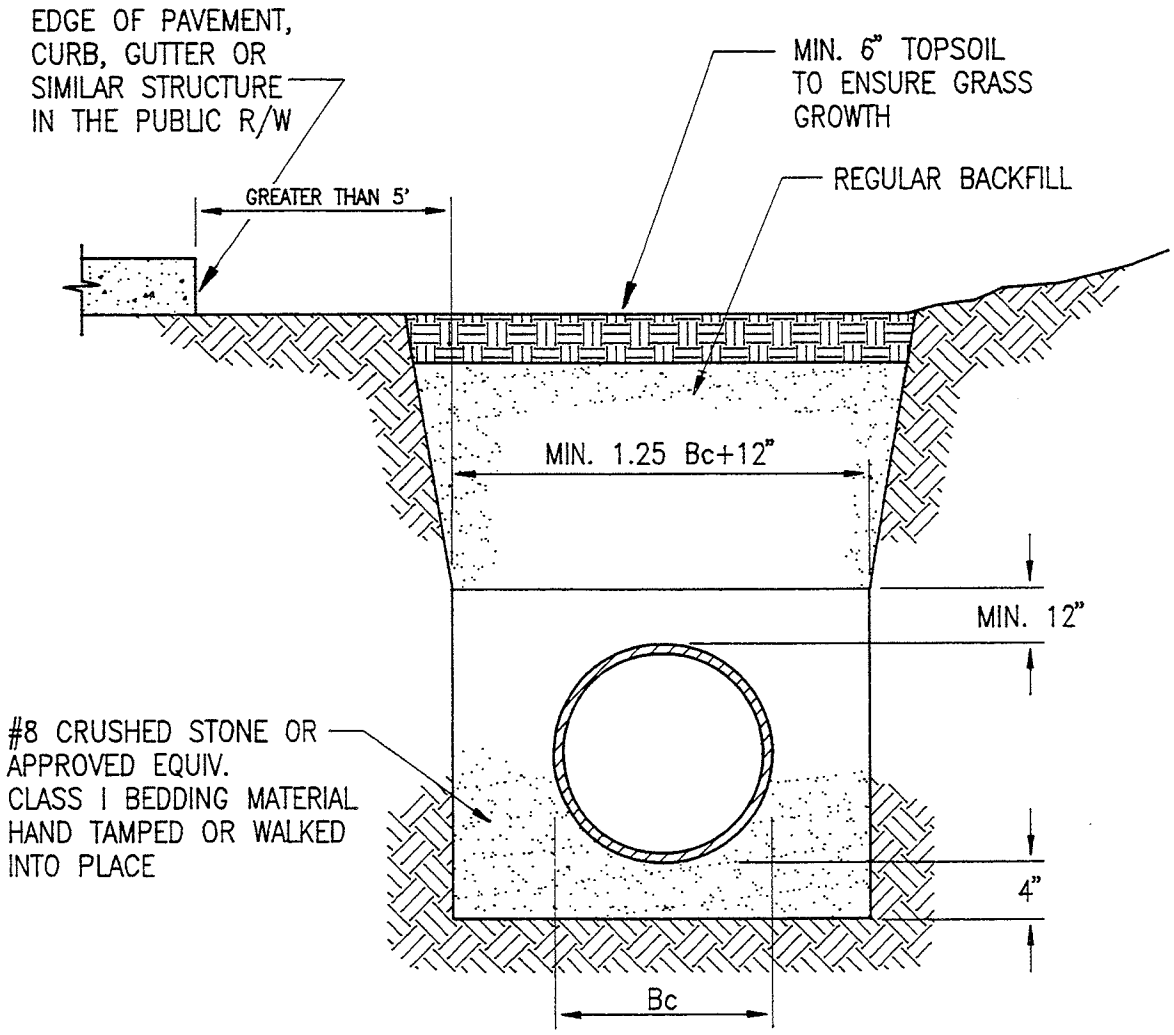
LEGEND

Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

PLASTIC PIPE (PVC & HDPE) TRENCH DETAIL

WITHIN 5" OF EDGE OF PAVEMENT

Figure 501-05



WITHIN 5" OF EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

A MINIMUM 9" CLEARANCE SHALL BE PROVIDED ON EACH SIDE OF THE INSTALLED PIPE

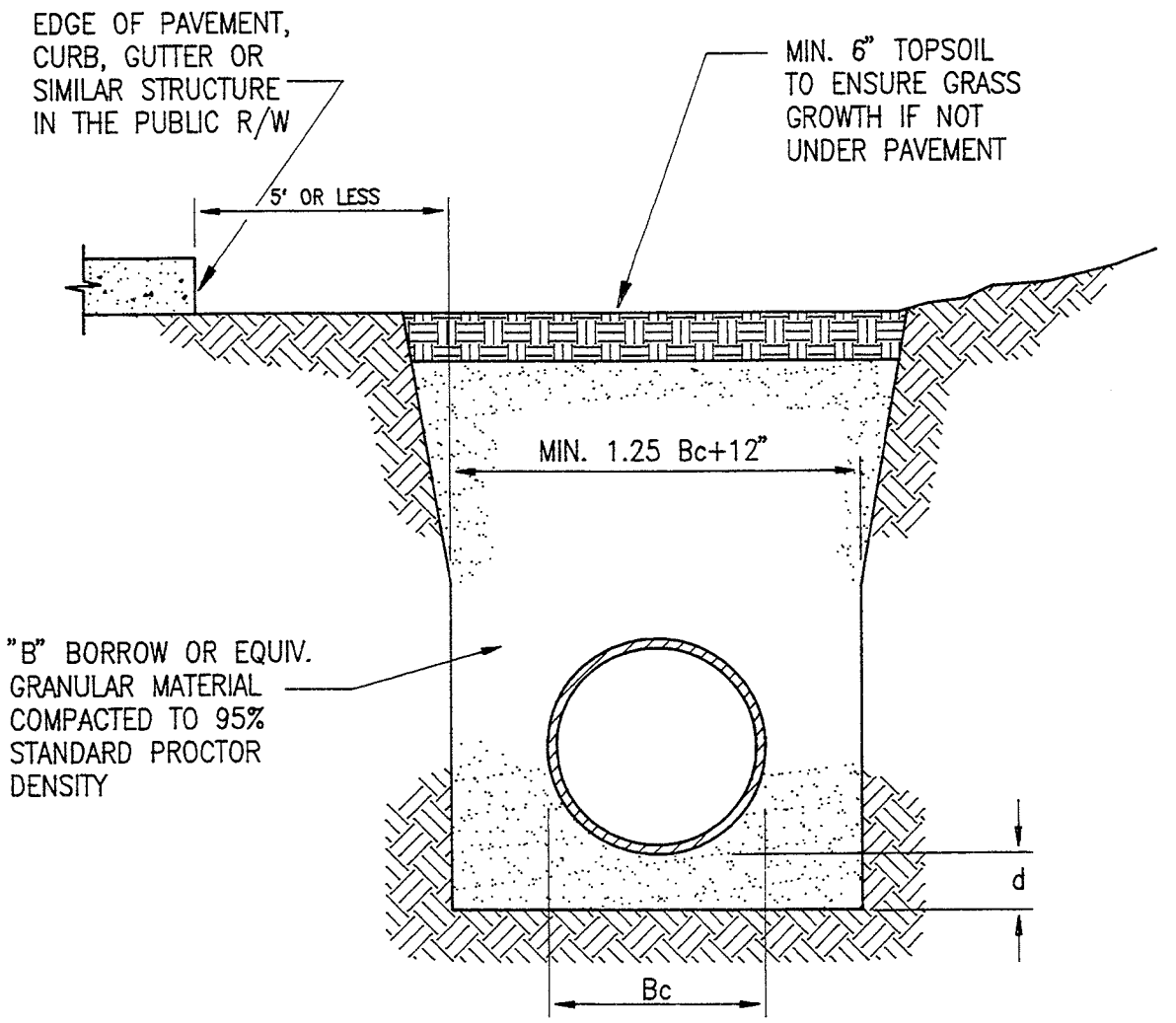
LEGEND

Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

PLASTIC PIPE (PVC & HDPE) TRENCH DETAIL

GREATER THAN 5' FROM EDGE OF PAVEMENT

Figure 501-06



WITHIN 5" OF EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

MIN. 9" OF CLEARANCE SHALL BE PROVIDED ON EACH SIDE OF THE INSTALLED PIPE

DEPTH OF BEDDING MATERIAL BELOW PIPE

D	(d) MIN.
27" & SMALLER	3"
30" TO 60"	4"
66" & LARGER	6"

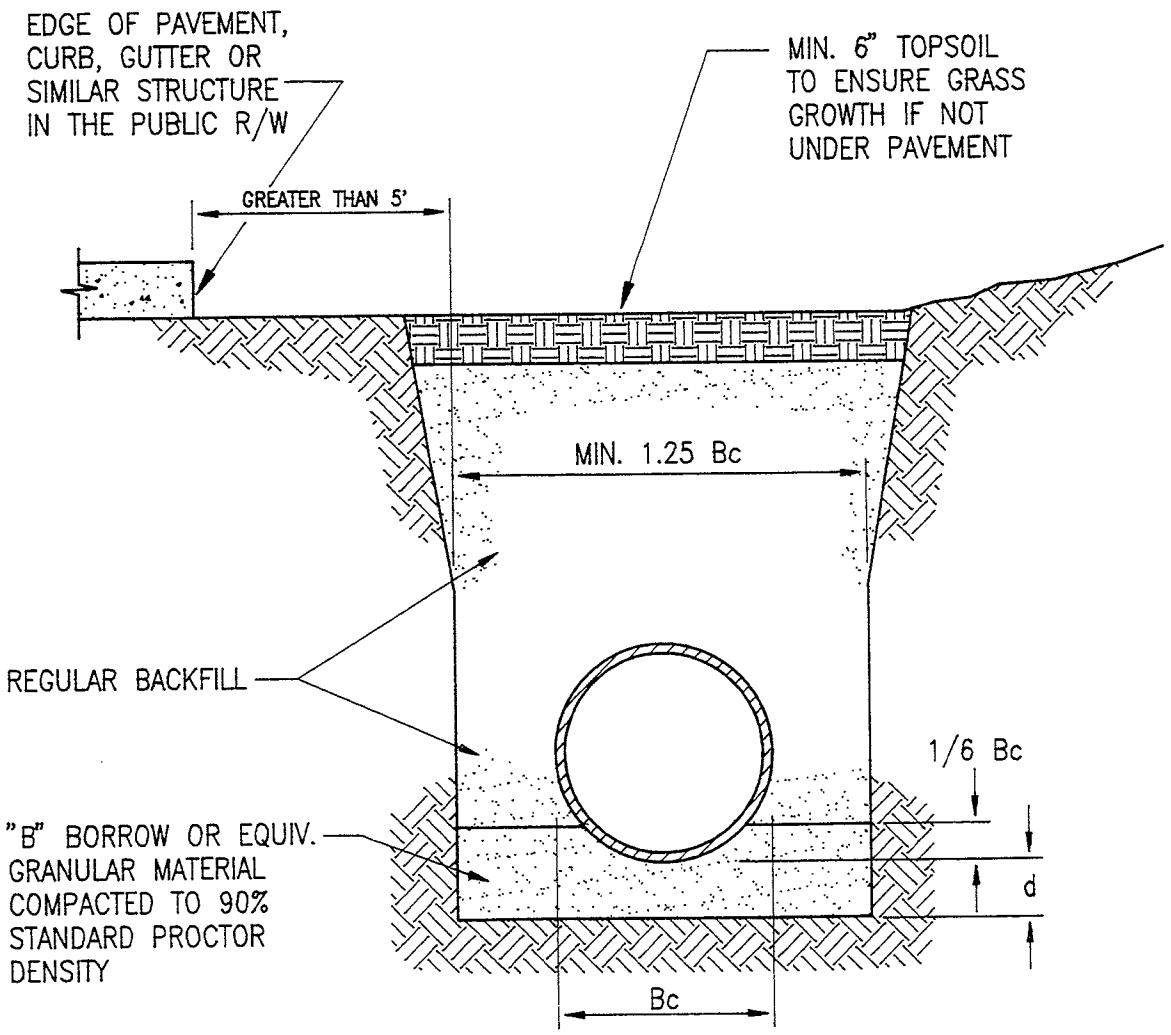
LEGEND

Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

REINFORCED CONCRETE PIPE (RCP) TRENCH DETAIL

WITHIN 5" OF EDGE OF PAVEMENT

Figure 501-07



GREATER THAN 5' FROM EDGE OF PAVEMENT

NOTE:
ALL BEDDING & INITIAL BACKFILL SHALL BE INSTALLED IN 6" TO 12" BALANCED LIFTS

MIN. 9" OF CLEARANCE SHALL BE PROVIDED ON EACH SIDE OF THE INSTALLED PIPE

DEPTH OF BEDDING MATERIAL BELOW PIPE

D	(d) MIN.
27" & SMALLER	3"
30" TO 60"	4"
66" & LARGER	6"

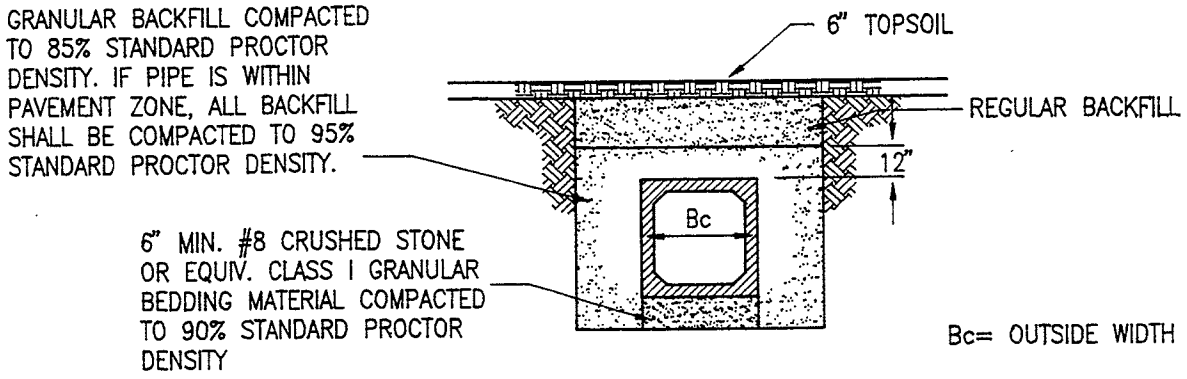
LEGEND

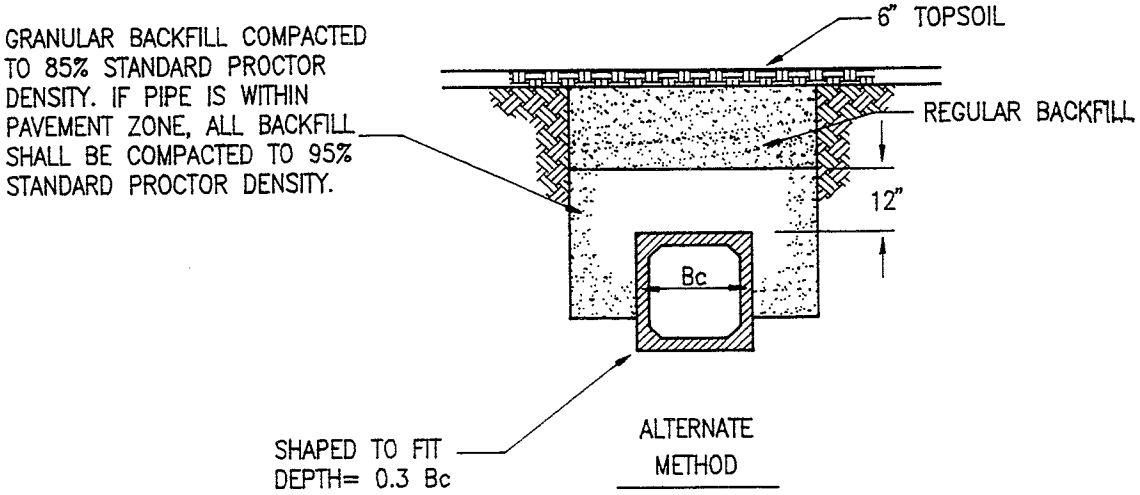
Bc = OUTSIDE DIAMETER
D = INSIDE DIAMETER
d = DEPTH OF BEDDING MATERIAL BELOW PIPE

REINFORCED CONCRETE PIPE (RCP) TRENCH DETAIL

GREATER THAN 5' FROM EDGE OF PAVEMENT

Figure 501–08

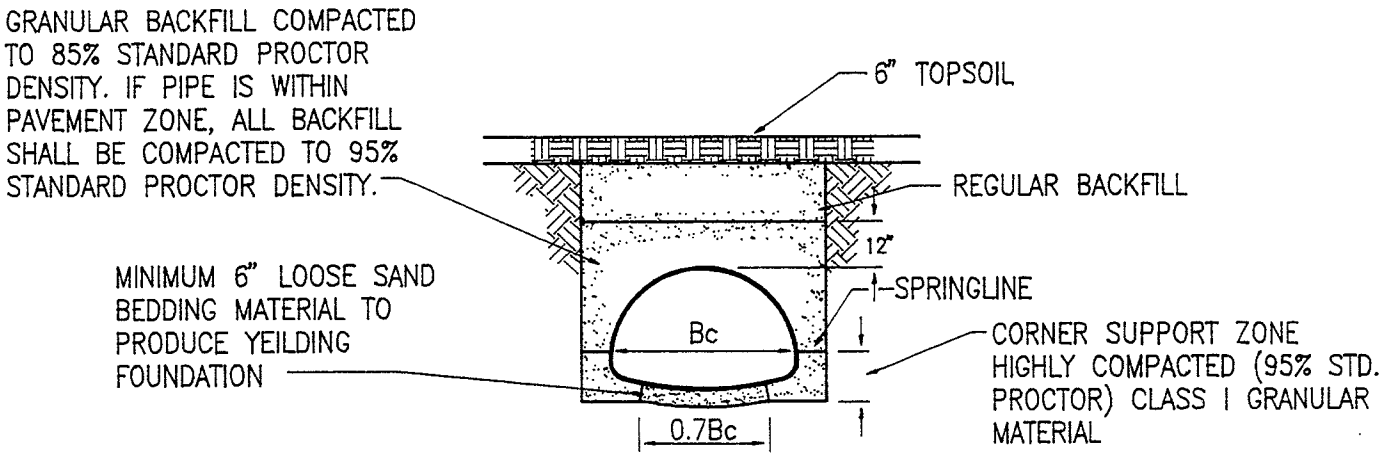


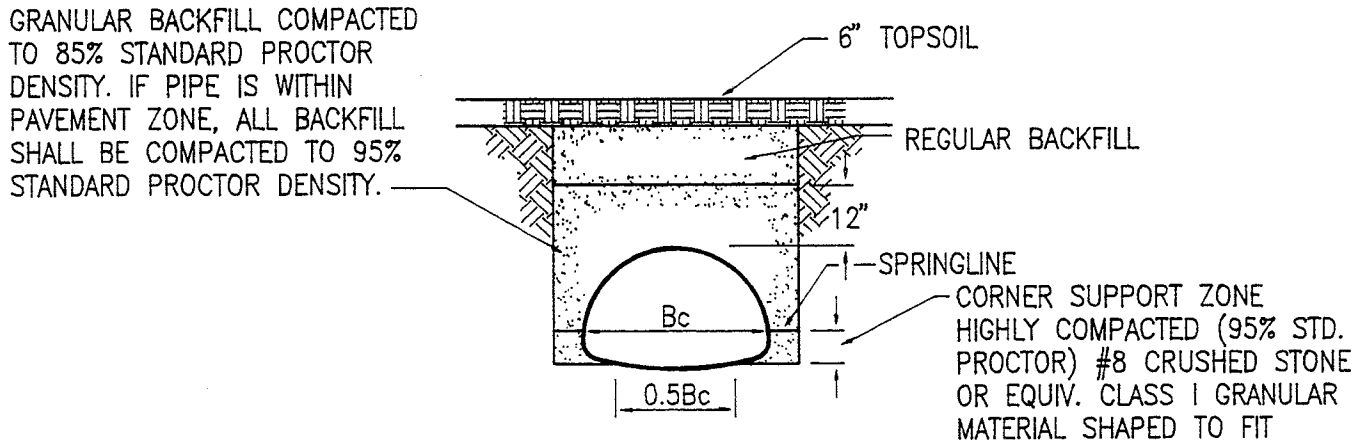


NOTE: REINFORCED CONCRETE BOX SECTIONS IN CONFORMANCE WITH ASTM C789 AND C850.
SOIL BEARING CAPACITY TO BE TESTED FOR CONFORMANCE WITH MINIMUM MANUFACTURER'S RECOMMENDATIONS.

REINFORCED CONCRETE BOX SECTION BEDDING DETAIL

Figure 501–09



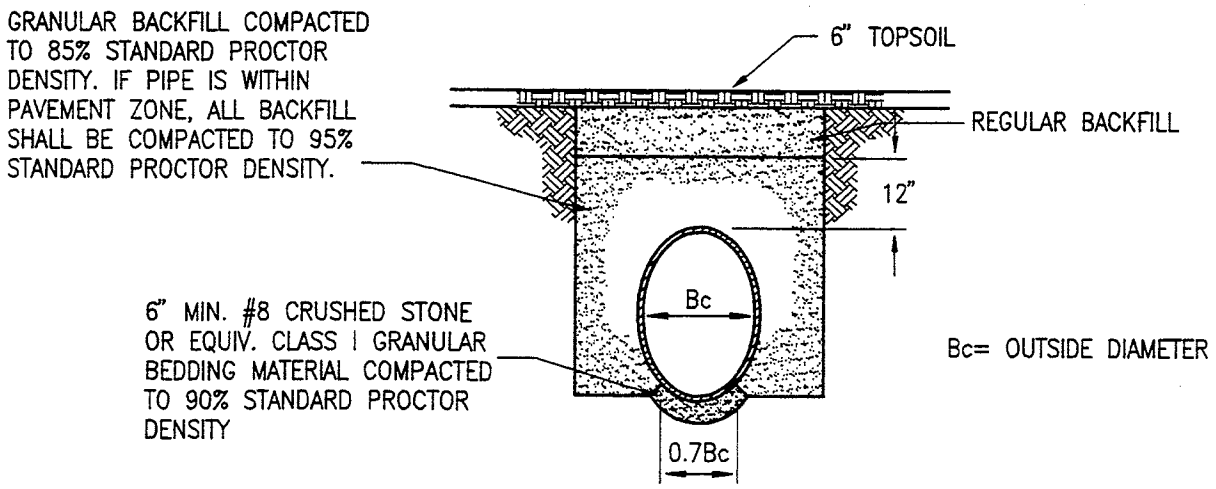


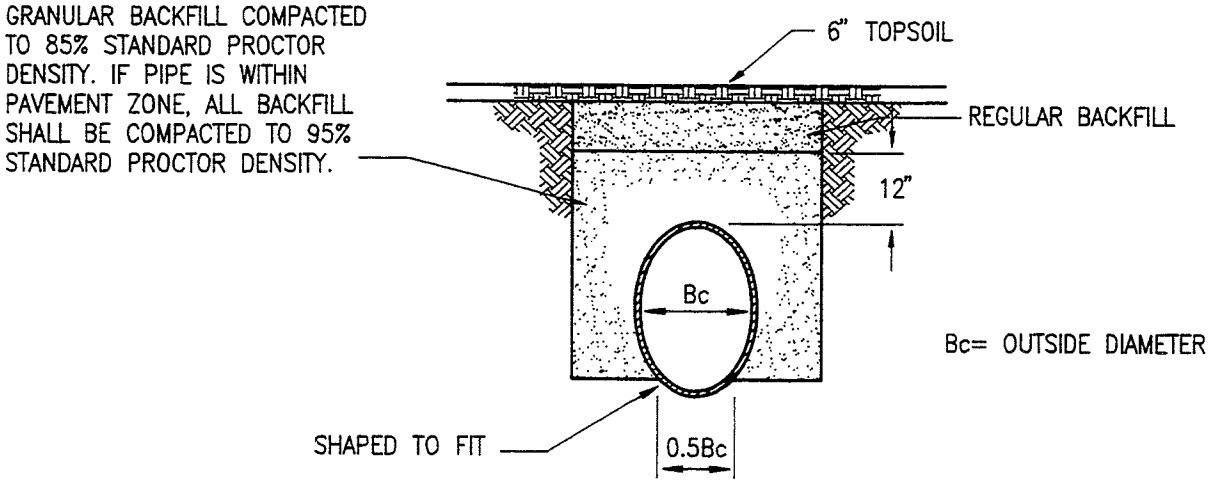
ALTERNATE METHOD

NOTE: SOIL BEARING CAPACITY TO BE TESTED FOR CONFORMANCE WITH MINIMUM MANUFACTURER'S RECOMMENDATIONS

STRUCTURAL PLATE METAL PIPE-ARCH BEDDING DETAIL

Figure 501-10



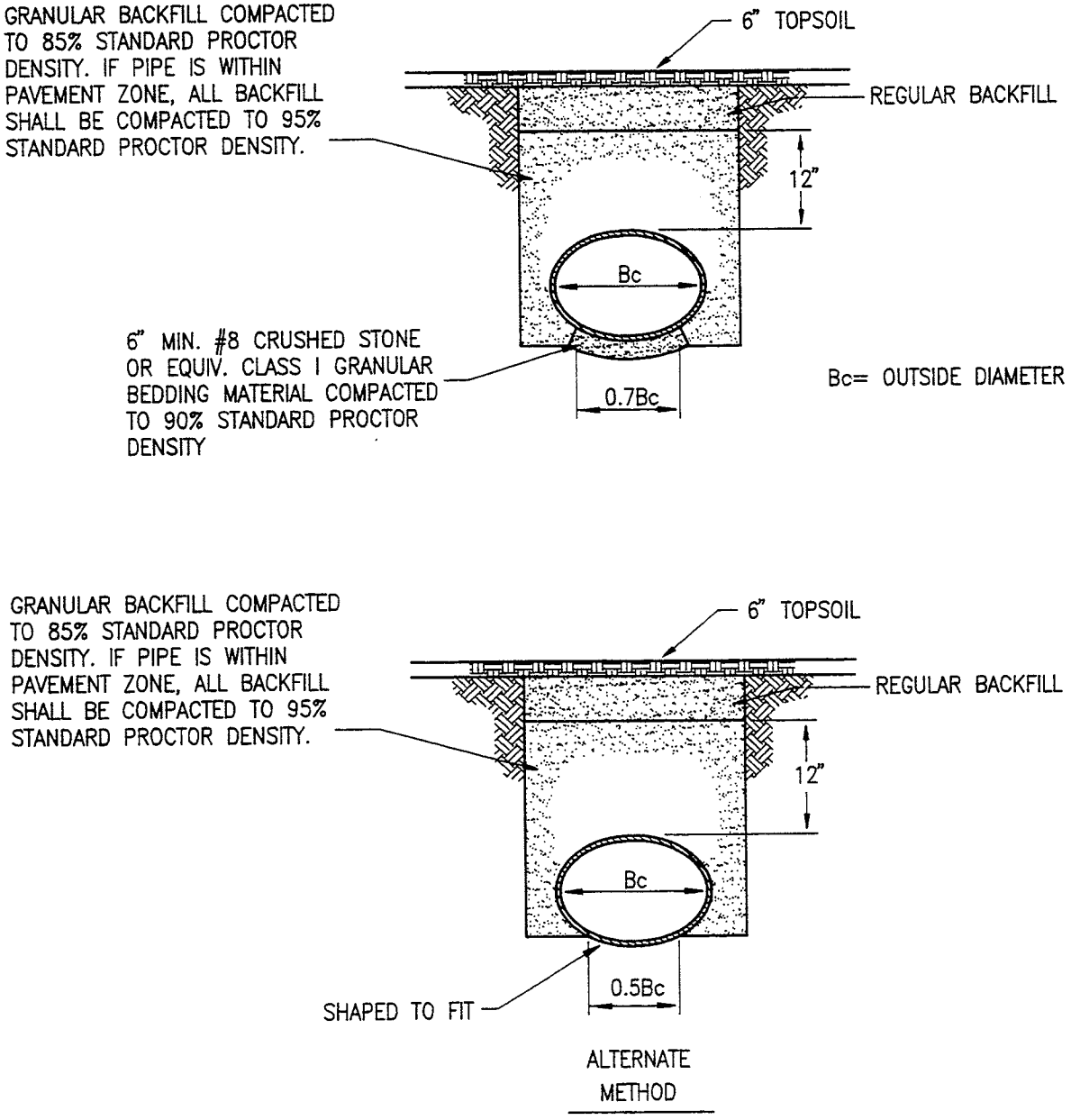


ALTERNATE METHOD

NOTE: REINFORCED CONCRETE ELLIPTICAL PIPE IN CONFORMANCE WITH ASTM C-76, CLASS HE-III, HE-IV, HE-V

REINFORCED CONCRETE VERTICAL ELLIPTICAL PIPE BEDDING DETAIL

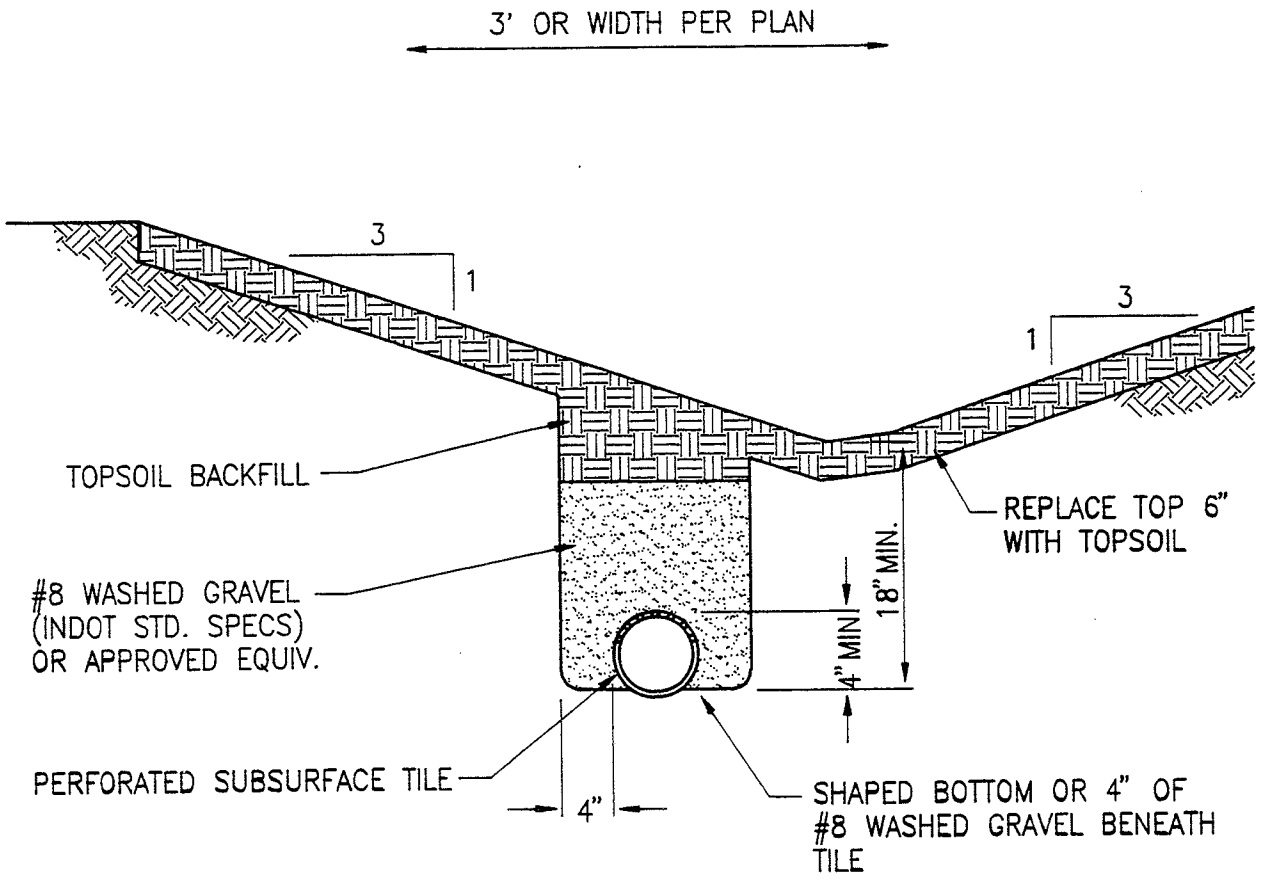
Figure 501-11



NOTE: REINFORCED CONCRETE ELLIPTICAL PIPE IN CONFORMANCE WITH ASTM C-76, CLASS HE-III, HE-IV, HE-V

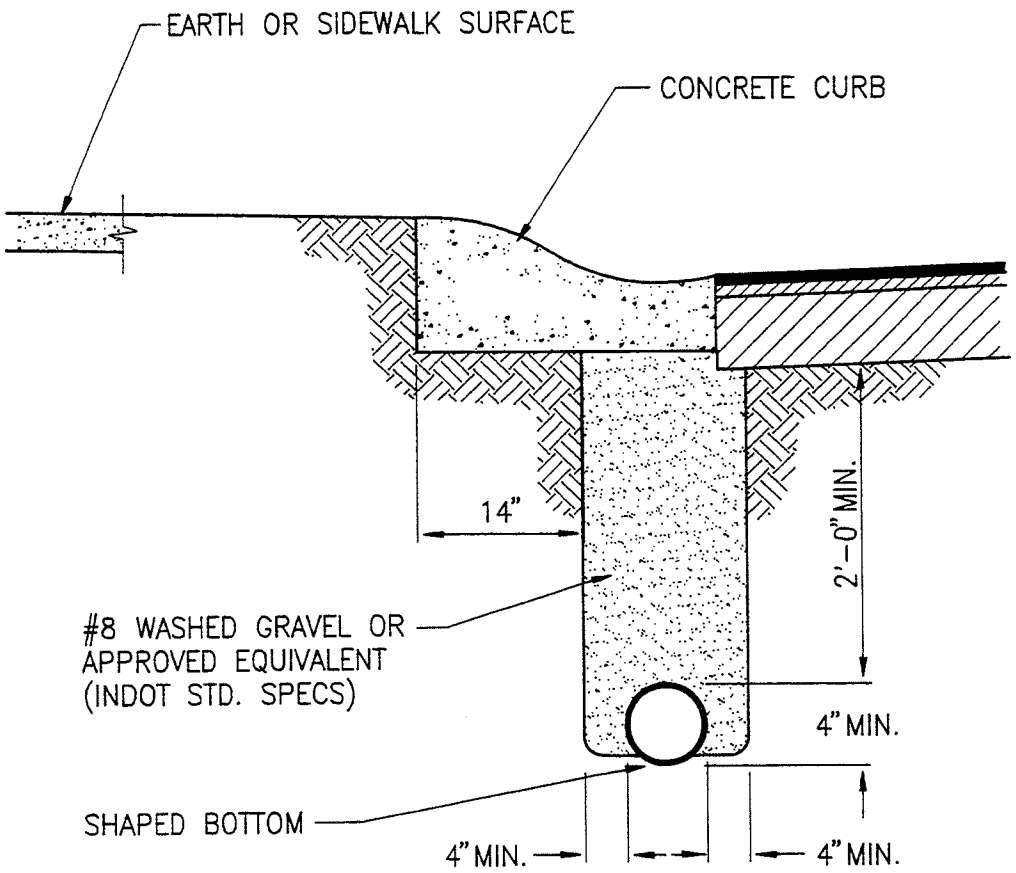
REINFORCED CONCRETE HORIZONTAL ELLIPTICAL PIPE BEDDING DETAIL

Figure 501-12



SWALE UNDERDRAIN DETAIL

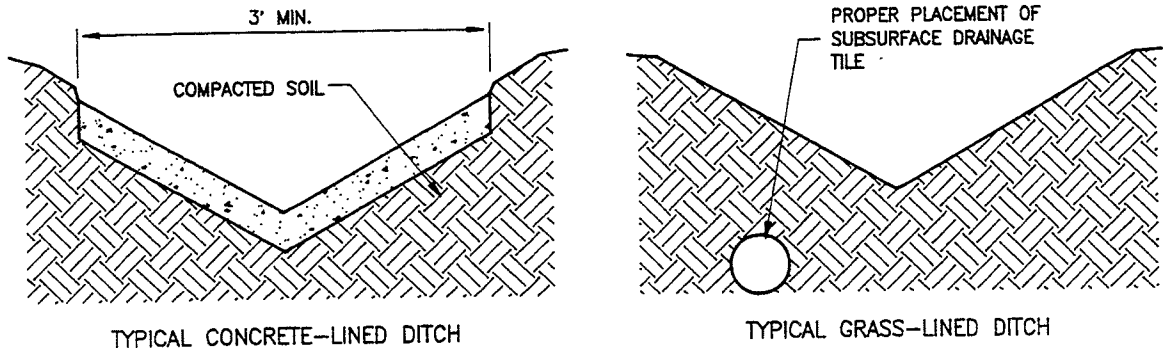
Figure 503-01



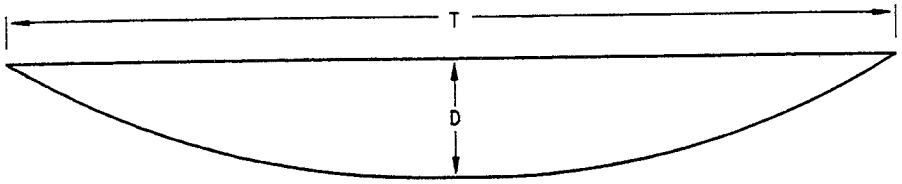
INSTALLATION REQUIRED:
BOTH SIDES OF ALL PAVEMENT,
UNLESS WAIVED IN WRITING BY
INDIANAPOLIS DEPARTMENT OF
CAPITAL ASSET MANAGEMENT
(DCAM)

CURB UNDERDRAIN DETAIL

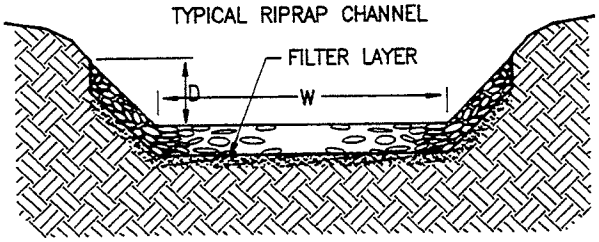
Figure 503-02

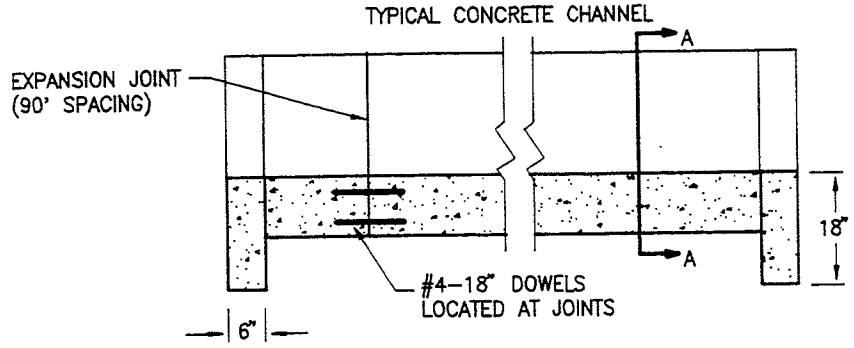


TYPICAL VEE CROSS-SECTIONS

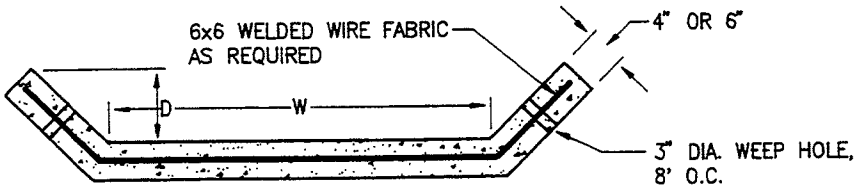


PARABOLIC WATERWAY CROSS-SECTION





NOT TO SCALE

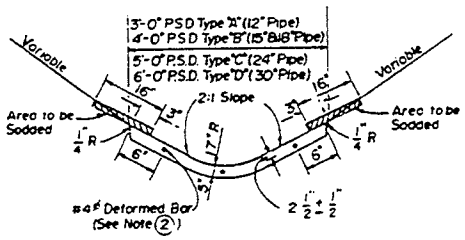


SECTION A-A

TRAPEZOIDAL WATERWAY CROSS-SECTIONS

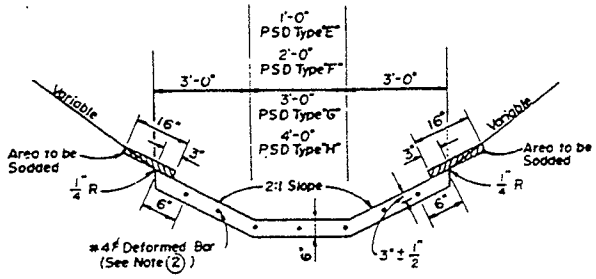
TYPICAL WATERWAY CROSS-SECTIONS

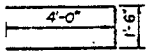
Figure 504-01



ELEVATION VIEW

PAVED SIDE DITCH TYPES "A" THRU "D"

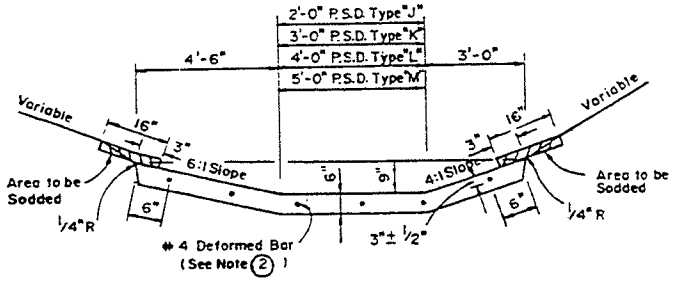




"U" BAR DETAIL

ELEVATION VIEW

PAVED SIDE DITCH TYPES "E" THRU "H"



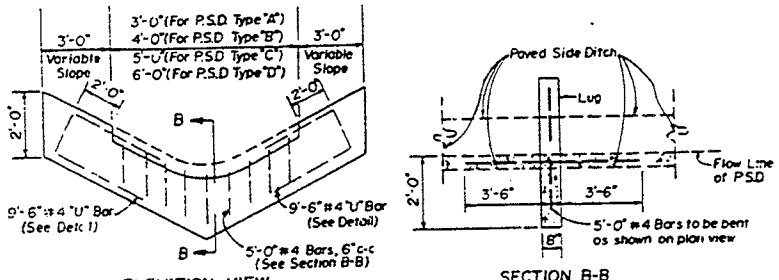
ELEVATION VIEW

PAVED SIDE DITCH TYPES "J" THRU "M"

② Reinforcement shall be required for all paved side ditch, cut-off-walls and lugs as shown. The reinforcing steel in the paved side ditch shall be spaced a maximum of one foot on centers.

PAVED SIDE DITCH DETAIL

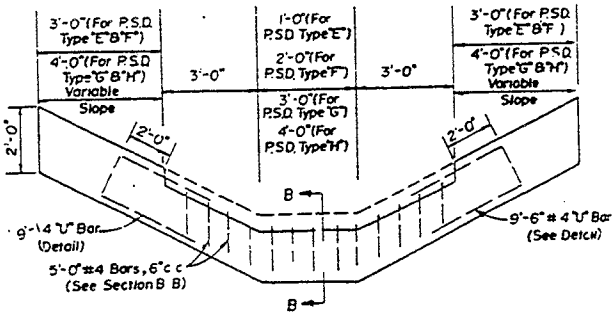
Figure 504-02



ELEVATION VIEW

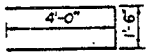
SECTION B-B

LUG FOR PAVED SIDE DITCH TYPES "A" THRU "D"

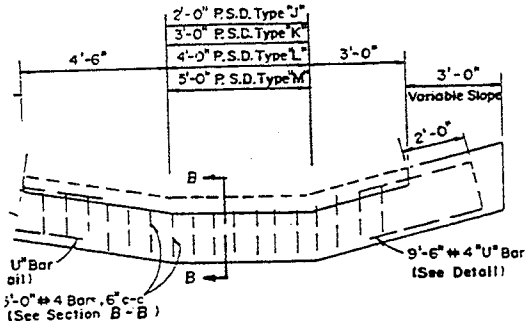


ELEVATION VIEW

LUG FOR PAVED SIDE DITCH TYPES "E" THRU "H"

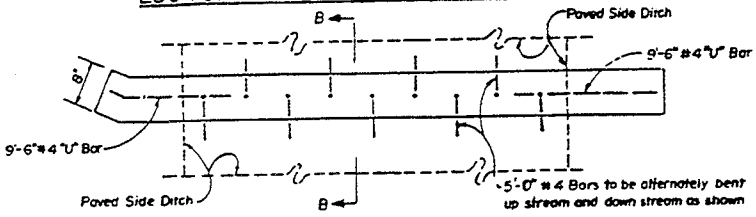


"U" BAR DETAIL



ELEVATION VIEW

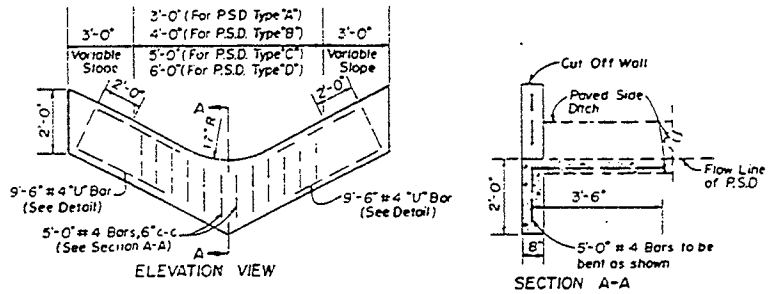
LUG FOR PAVED SIDE DITCH TYPES "J" THRU "M"



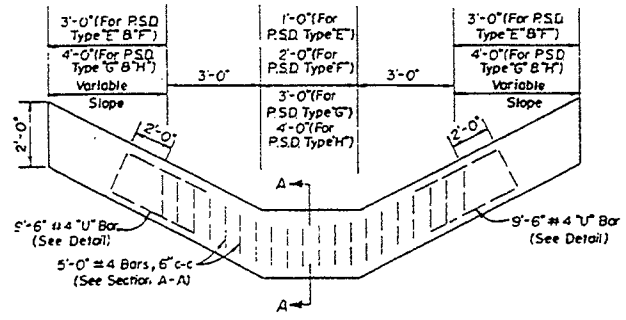
PLAN VIEW OF LUGS (TYPICAL FOR ALL TYPES)

PAVED SIDE DITCH LUG DETAIL

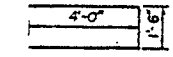
Figure 504-03



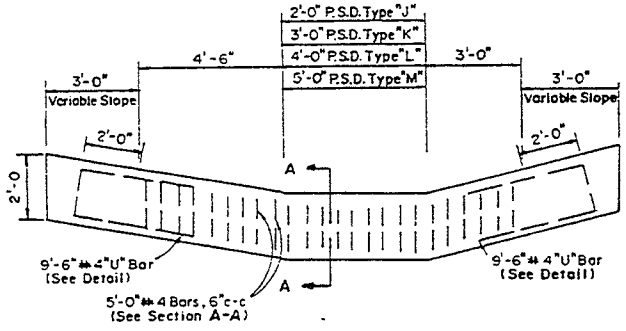
CUT-OFF-WALL FOR PAVED SIDE DITCH TYPES "A" THRU "D"



CUT-OFF-WALL FOR PAVED SIDE DITCH TYPES "E" THRU "H"



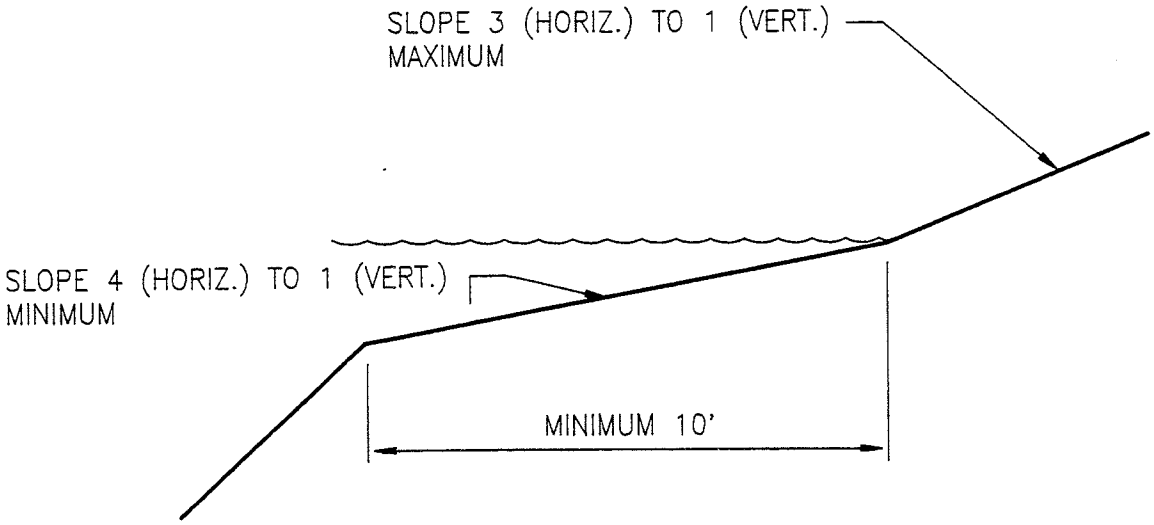
"U" BAR DETAIL



CUT-OFF-WALL FOR PAVED SIDE DITCH TYPES "J" THRU "M"

PAVED SIDE DITCH CUT-OFF-WALL DETAIL

Figure 504-04



DETENTION FACILITIES WITH NORMAL POOL

Figure 505-01